Reader's Choice: Chemistricks

Mar 19
Rs.30/-

CHEMISTRY TIMES

Get your Digital version [CHEMISTRY TIMES] Available

www.pcmbtimes.com | www.evalearning.in

Concept Of The Month

Pyrometallurgical Extraction

Quick Recap-2

GLIMPSE OF "ELITE SERIES"

Previous Year JEE MAIN & NEET Questions

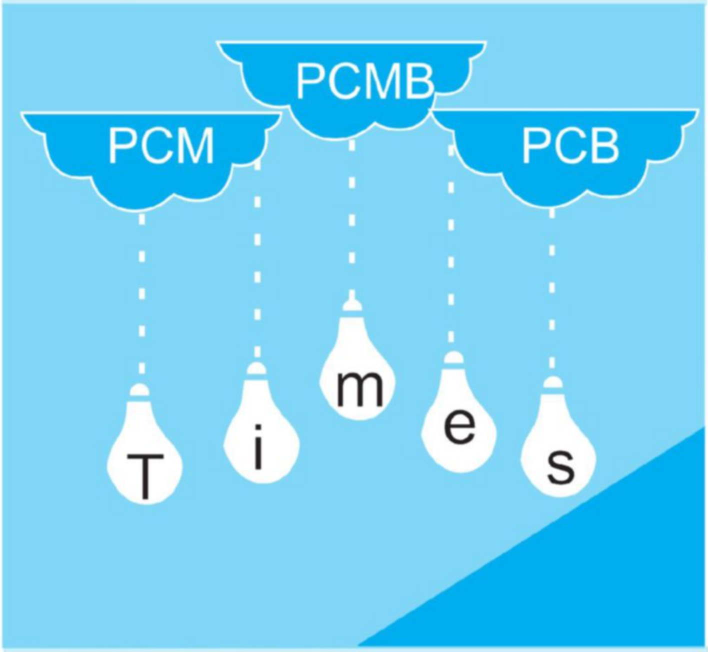
MOCK TEST PAPER (NEET)-5, (JEE MAIN)-4

MARCH 2019

CHEMISTRY TIMES

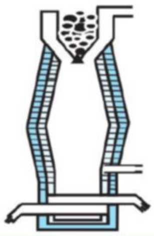
SRI ABHAY PUBLICATIONS

VOL-V



CONTENTS

OWNED, PRINTED & PUBLISHED BY:
Eswar Reddy Alla, From Flat No:310, Fort House Apartment,
Balaji Layout, Kodigehalli, Bangalore-560092
PRINTED AT:
JAYAM PRINT SOLUTION, S.NO: 77/A, New Raja Rajeswaripet, Ajith Singh Nagar,
Vijayawada, Andhra Pradesh - 520015



Pyrometallurargical Extraction

Concept of the month

This column is aimed at preparing students for all competitive exams like JEE, NEET, BITSAT etc. Every concept has been designed by highly qualified faculty to cater to the needs of the students by discussing the most complicated and confusing concepts in Chemistry.

By: P. BRAHMA REDDY
(Alumni from IIT Delhi)

Introduction

- The process of extraction of metal from its ores in profitable manner is called metallurgy.
- **Mineral** is a substance in which metal is present in either native state or in combined state.
- **Ore** is the mineral from which the metal can be economically and conveniently extracted.
- **Gangue or matrix** is the impurities present in the ore.
- **Extraction of pure metal** from its ore done in various steps, which are given in the flow chart.

In this article much focus given towards the extraction of some metals based on thermodynamic principles i.e., pyrometallurigcal process.

Thermodynamic principles in extraction of metals

- In metallurgical operations the selection of a suitable, reducing agent for reduction of a particular oxide can be decided on the basis of thermodynamic principles.
- The optimum temperature at which reduction can occur smoothly can also be predicted using thermodynamic principle.
- The Gibbs free energy change ΔG of a reaction is a measure of the thermodynamic driving force that makes a reaction occur. A negative value for ΔG indicates that a reaction can proceed spontaneously without any external inputs, while a positive value indicates that it will not.

Ore

↓

Powdered ore

Removal of gangue

- Hydraulic washing (for carbonate and oxide ores)
- Froth floatation (for sulphide ores)
- Electromagnetic separation (for magnetic ores)
- Electrostatic seperation (for PbS and ZnS)
- Leaching (for Ag, Al, Au)

↓

Concentrated ore

- Calcination (for carbonate and hydroxide ores)
- Roasting (for sulphide ores)

↓

Metal oxide

↓

- Smelting
- Reduction with Mg, Al
- Reduction with H_2, water gas

↓

Crude metals

Refining

- Liquation
- Poling
- Electrorefining
- Zone refining
- Vapour phase refining
- Chromatography

↓

Pure metal

- For feasibility of any reaction at any temperature the value of ΔG must be negative at that temperature.

$$\boxed{\Delta G = \Delta H - T.\Delta S}$$

Enthalpy term   Entropy term

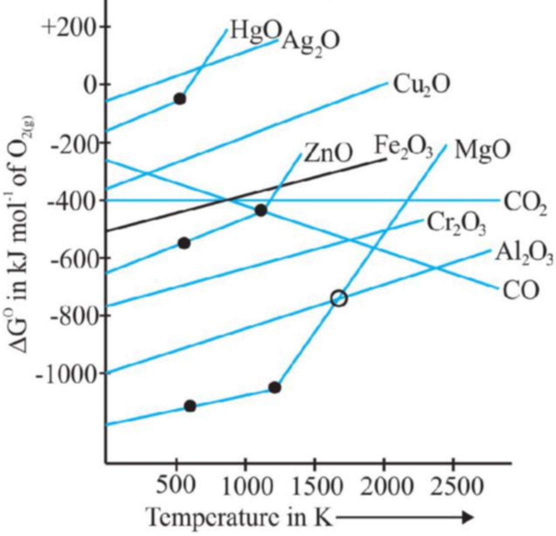
ΔH : – Measure of actual energy that is liberated when the reaction occurs.

ΔS : – Measure of the change in the possibilities for disorder in the products compared to the reactants.

- Greater the negative value of ΔG, higher is the reducing power of an element.
- For the reduction of a metal oxide with a reducing agent, the plot of ΔG^o vs temperature is studied, which is called Ellingham diagram.

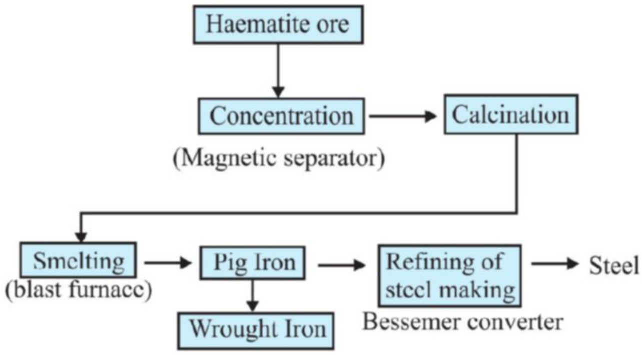
Characteristics of Ellingham diagram

- ΔG^o becomes more positive when temperature increases, i.e., stability of oxides decreases.
- A metal will reduce the oxide of other metals which lie above it in Ellingham diagram, i.e., the metals for which the free energy of formation (ΔG^o) of their oxides is more negative can reduce those metal oxides which has less negative ΔG^o. Thus, Al reduces FeO, CrO and NiO in thermite reduction but it will not reduce MgO at temperature below 1773K.
- CO is more effective reducing agent below 1073K and above 1073K coke is more effective reducing agent, e.g., CO reduces Fe_2O_3 below 1073K but above it, coke reduces Fe_2O_3.



Extraction of Iron

- **Ores :** Haematite – Fe_2O_3 Limonite – $2Fe_2O_3.3H_2O$; Siderite $FeCO_3$; Magnetite – Fe_3O_4, Pyrite- FeS_2.
- **Process:**



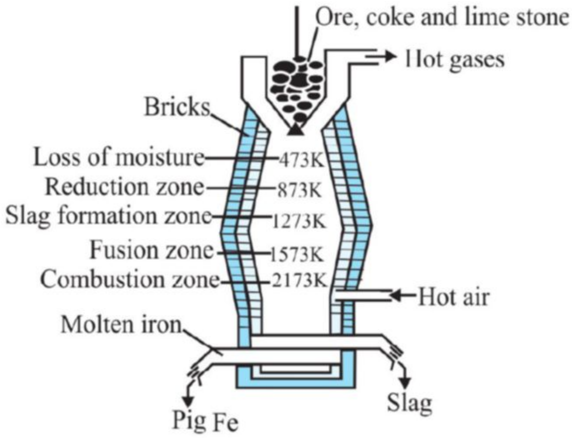


Fig:Blast furnace

- **Reactions :**

(i) Roasting : FeO changes to Fe_2O_3 to prevent the loss of iron during smelting.

$$4FeO + O_2 \rightarrow 2Fe_2O_3$$

(ii) Smelting (In blast furnace) :

In reduction zone :

At 400°C, $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$

$$Fe_3O_4 + CO \rightarrow 3FeO + CO_2$$

At 600°C, $FeO + CO \rightarrow Fe + CO_2$

$$CaCO_3 \rightarrow CaO + CO_2$$

In central zone:

$$FeO + 3CO \rightarrow 2CO_2 + C + Fe$$

(900 – 1200°C) Fe acts as catalyst here and 'C' so formed is dissolved in Fe.

$$\underset{(flux)}{CaO} + \underset{(impurity)}{SiO_2} \rightarrow \underset{(slag)}{CaSiO_3}$$

In fusion zone

$$CO_2 + C \rightarrow 2CO, \ \Delta H = +ve$$

(1100 – 1200°C) melting of iron takes place

In combustion zone

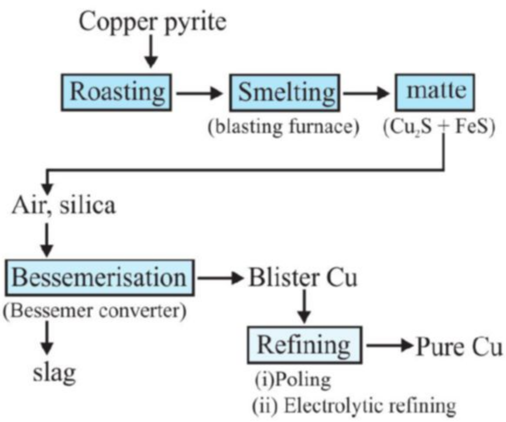
$$2C + O_2 \rightarrow 2CO, \ \Delta H = -ve$$

(1500 – 1600ºC)

- **Pig Iron:** C - 3.1 – 4.5%, small amounts of Si, S, P ; hard and brittle, obtained from blast furnace
- **Wrought Iron:** C - 0.15 – 0.28%, purest form ; malleable, fibrous
- **Steel:** C - 0.15 – 1.5%, strength is high.

Extraction of Copper

- **Ores :** Copper pyrites $CuFeS_2$; Cuprite or ruby copper Cu_2O ; Copper glance Cu_2S ; Malachite $Cu(OH)_2 . CuCO_3$; Azurite $Cu(OH)_2 . 2CuCO_3$.
- **Process:**



- **Reactions :**

(i) Roasting :

$$2CuFeS_2 + O_2 \rightarrow Cu_2S + 2FeS + SO_2$$

$$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2$$

$$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$$

(ii) Smelting :

$$Cu_2O + FeS \rightarrow Cu_2S + FeO$$

$$FeO + SiO_2 \rightarrow FeSiO_3$$

(iii) Bessemerisation :

$$2FeS + 3O_2 \rightarrow 2FeO + 2SO_2$$

$$FeO + SiO_2 \rightarrow FeSiO_3$$

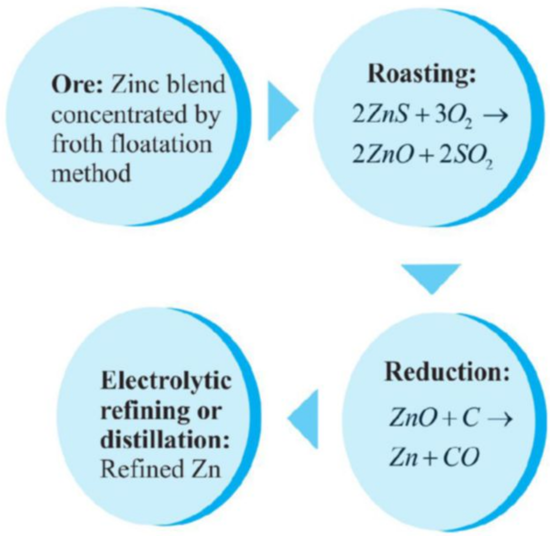
$$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$$

$$Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2 \ \text{(self reduction)}$$

- **Poling :** Molten Cu is stirred with poles of green wood to reduce any copper oxide in Copper
- **Electrolytic refining :** Anode – impure Cu ; cathode – pure Cu ; electrolyte - $CuSO_4 + H_2SO_4$.

Note : Copper can be extracted by hydrometallurgical process also

Extraction of Zinc



Exercise

1. Composition of azurite mineral is
   (a) $CuCO_3.CuO$ (b) $Cu(HCO_3)_2.Cu(OH)_2$
   (c) $2CuCO_3.Cu(OH)_2$ (d) $CuCO_3.2Cu(OH)_2$
2. The process is used to remove reductible oxides from metals. Molten impure metal is stirred by a wooden rods. The hydrocarbon gases reduce the oxides. The process is called
   (a) Zone refining (b) Cupellation
   (c) Poling (d) Leaching
3. Roasted copper pyrite on smelting with sand produces
   (a) $FeSiO_3$ as fusible slag and Cu_2S as matte
   (b) $CaSiO_3$ as infusible slag and Cu_2O as matte
   (c) $Ca_3(PO_4)_2$ as fusible slag and Cu_2S as matte
   (d) $Fe_3(PO_4)_2$ as infusible slag and Cu_2S as matte

4. Which series of reactions correctly represents chemical relations related to iron and its compound?

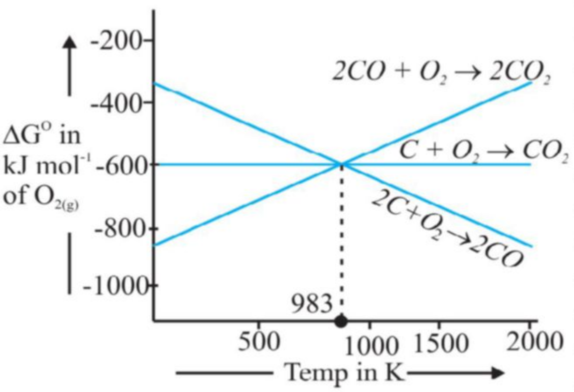
(a) $Fe \xrightarrow{O_2, heat} Fe_3O_4 \xrightarrow{CO, 600^\circ C} FeO \xrightarrow{CO, 700^\circ C} Fe$

(b) $Fe \xrightarrow{dil.H_2SO_4} FeSO_4 \xrightarrow{H_2SO_4, O_2} Fe_2(SO_4)_3 \xrightarrow{heat} Fe$

(c) $Fe \xrightarrow{O_2, heat} FeO \xrightarrow{dil.H_2SO_4} FeSO_4 \xrightarrow{heat} Fe$

(d) $Fe \xrightarrow{Cl_2, heat} FeCl_3 \xrightarrow{heat, air} FeCl_2 \xrightarrow{Zn} Fe$

5.



From the given Ellingham diagram which is a better reducing agent at 673k?

(a) C (b) CO

(c) CO_2 (d) Any of these

6. Why are the slopes of many of the lines on the Ellingham diagram almost identical?

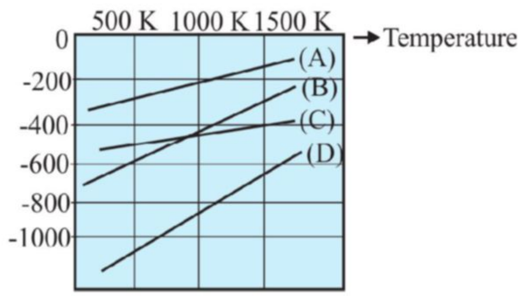
(a) Most reactions involve the elimination of one mole of gas, so there is a similar standard enthalpy change of a reaction.

(b) Most reactions involve the elimination of one mole of gas, so there is a similar standard entropy change of a reaction.

(c) The activity of the most of the metals is same.

(d) The partial pressure of the reacting gas is the same for all reactions.

7. For Fe_3O_4 (solid), standard enthalpy of formation is -1120 kJ mol^{-1}. Change in entropy, under standard conditions, for the formation of 1 mol of Fe_3O_4 is -350 J K^{-1} mol^{-1}. Which of the following graphs is the Ellingham diagram for Fe_3O_4?



(a) A (b) B (c) C (d) D

8. In the extraction of iron metal from haematite ore, $CaCO_3$ (lime stone) is one of the constituents of the charge. The role of $CaCO_3$ in the extraction process is to

(a) reduce oxides of iron by providing CO_2 gas

(b) oxidize the metallic impurities to respective oxides

(c) lower the temperature at which haematite gets reduced to iron

(d) provide CaO to gangue which is separated as slag

9. Which is NOT true for both (A) extraction of iron from haematite ore and (B) extraction of tin from tin stone (cassiterite)?

(a) The ore is an oxide ore

(b) Pyrometallurgical extractive method is used for extraction of the metal from the ore

(c) The function of C is to act as a reducing agent

(d) Purification is carried out by zone melting

10. Highly electropositive metals cannot be extracted by carbon reduction process because these:

(a) Metals do not react with carbon

(b) Metals do not combine with carbon to form carbides

(c) Metal oxides are not reduced by carbon

(d) Loss of metal is more by vaporisation

11. **Statement-I:** Carbon monoxide is capable of reducing FeO to Fe at certain temperature.

Statement-II: At the given temperature, standard free energy of reaction, $2Fe + O_2 \rightarrow 2FeO$ is more negative compared to the standard free energy of the reaction, $2CO + O_2 \rightarrow 2CO_2$

(a) Statement-I and Statement-II are true and Statement-II is the correct explanation of Statement-I.

(b) Statement-I and Statement-II are true, but Statement-II is not the correct explanation of

Statement -I

(c) Statement-I is true, but Statement -II is false

(d) Statement-I is false, but Statement -II is true

12. **Statement-I:** The precious metal, silver present as impurity in the metal lead may be recovered by treating molten impure lead with molten zinc.

Statement-II: Under equilibrium conditions, in a mixture of two immiscible liquids (molten lead and molten zinc), when silver is dissolved, the concentration of silver in molten zinc is much higher than its concentration in molten lead.

(a) Statement-I and Statement-II are true and Statement-II is the correct explanation of Statement-I.

(b) Statement-I and Statement-II are true, but Statement-II is not the correct explanation of Statement -I

(c) Statement-I is true, but Statement -II is false

(d) Statement-I is false, but Statement -II is true

13. Consider the following reactions at 1000°C

(1) $Zn(s)+\frac{1}{2}O_2(g)\rightarrow ZnO(s) \quad \Delta G^o=-360\,kJ\,mol^{-1}$

(2) $C(s)+\frac{1}{2}O_2(g)\rightarrow CO(g) \quad \Delta G^o=-460\,kJ\,mol^{-1}$

Choose the correct statement at 1000°C

(a) Zinc can be oxidized by CO.

(b) Zinc oxide can be reduced by carbon

(c) Both statements A and B are true

(d) Both statements A and B are false

14. Consider the oxidation reaction

$$\frac{2x}{y}\underset{Metal(s)}{M}+\underset{(g)}{O_2}\rightarrow\frac{2}{y}\underset{Metal\ oxide(s)}{M_xO_y}$$

Choose the incorrect statement.

(a) Oxygen has higher entropy than the metal but lesser entropy than the metal oxide.

(b) ΔS^o for the oxidation reaction would be negative

(c) ΔG^o would become less and less negative with increase in temperature

(d) If the temperature is very high, ΔG^o may become zero, and even positive.

15.

Column- I (Reaction)	Column-II (Temperature)
(i) $CaO+SiO_2\rightarrow CaSiO_3$	(P) 1000°C
(ii) $C+CO_2\rightarrow 2CO$	(Q) 900°C
(iii) $CaCO_3\rightarrow CaO+CO_2$	(R) 400°C
(iv) $3Fe_2O_3+CO\rightarrow 2Fe_3O_4+CO_2$	(S) 1800°C

ANSWER KEY

1. c	2. c	3. a	4. a
5. b	6. b	7. c	8. d
9. d	10. d	11. c	12. a
13. b	14. a		

15. (i) → (Q), (ii) → (P), (iii) → (Q), (iv) → (R)

HINTS & SOLUTIONS

1.Sol: Azurite is a basic copper carbonate ore having composition $2CuCO_3.Cu(OH)_2$.

3.Sol: During smelting, silica combines with FeO to form fusible $FeSiO_3$ slag and Cu_2S as matte.

4.Sol: Combustion of Fe to give Fe_3O_4 which upon reduction with CO first gives FeO and finally Fe. Option (b) and (c) are wrong because $FeSO_4$ and $Fe_2(SO_4)_3$ on heating gives $Fe_2O_3.SO_2.SO_3$ and not Fe.

$$Fe_2(SO_4)_3\xrightarrow{\Delta}Fe_2O_3+3SO_3$$

$$2FeSO_4\xrightarrow{\Delta}Fe_2O_3+SO_3+SO_2$$

Option (d) is wrong because in presence of air, reduction of $FeCl_3$ to $FeCl_2$ cannot occur.

5.Sol: From the diagram ΔG^o for formation of CO_2 from CO is more -ve than formation of CO (or) CO_2 from carbon at 673K.
Hence CO is a better reductant than C at 673K.

6.Sol: Most of the reactions have similar ΔS^o value.

11.Sol: At the given temperature, free energy of reaction, $2Fe+O_2\rightarrow 2FeO$, is LESS negative.

GLIMPSE OF ELITE SERIES

MOLECULAR ORBITAL THEORY

1. While filling electrons in $\pi 2p_x$ and $\pi 2p_y$ the electronic configuration rules that has to be followed is
(a) Pauli's exclusion principle
(b) Aufbau principle
(c) Both Pauli's and Hund's rule
(d) All the above

2. The paramagnetic nature of oxygen is best explained by
(a) V.B.theory (b) Hybridisation
(c) M.O.theory (d) VSEPR theory

3. Maximum number of electrons that can be present in any molecular orbital is
(a) 3 (b) 6 (c) 8 (d) 2

4. Which molecule/ion out of the following does not contain unpaired electrons?
(a) N_2^+ (b) O_2 (c) O_2^{2-} (d) B_2

5. Which of the following cannot be formed?
(a) He^{2+} (b) He^+ (c) He (d) He_2

6. A bonding molecular orbital is produced by
(a) Destructive interference of wave functions
(b) Constructive interference of wave functions
(c) Pairing of electrons with opposite spins
(d) Combination of +ve and –ve wave functions

7. Which of the following statements is not correct regarding bonding molecular orbitals ?
(a) Bonding molecular orbitals possess less energy than the atomic orbitals from which they are formed.
(b) Bonding molecular orbitals have low electron density between the two nuclei.
(c) Electron in bonding molecular contibutes to the attraction between atoms.
(d) They are formed when the lobes of the combining atomic orbitals have the same sign.

8. The wavelength of the wave function of a bonding molecular orbital formed by LCAO is
(a) Equal to the wave function of atomic orbital
(b) Less than the wave function of atomic orbital
(c) Greater than the wave function of atomic orbital
(d) Double the wave function of atomic orbital

9. Which of the following order of energies of molecular orbitals of N_2 is correct?
(a) $(\pi 2p_y) < (\sigma 2p_z) < (\pi^* 2p_x) \approx (\pi^* 2p_y)$
(b) $(\pi 2p_y) > (\sigma 2p_z) > (\pi^* 2p_x) \approx (\pi^* 2p_y)$
(c) $(\pi 2p_y) < (\sigma 2p_z) > (\pi^* 2p_x) \approx (\pi^* 2p_y)$
(d) $(\pi 2p_y) > (\sigma 2p_z) < (\pi^* 2p_x) \approx (\pi^* 2p_y)$

10. Which one is paramagnetic and has a bond order of $\frac{1}{2}$?
(a) O_2^- (b) N_2^+ (c) F_2 (d) H_2^+

11. Which of the following options represents the correct bond order?
(a) $O_2^- > O_2 > O_2^+$ (b) $O_2^- < O_2 < O_2^+$
(c) $O_2^- > O_2 < O_2^+$ (d) $O_2^- < O_2 > O_2^+$

12. In which pair, the stronger bond found in the first species
(I) O_2^-, O_2 (II) N_2, N_2^+ (III) NO^+, NO^-
(a) (I) only (b) (II) only
(c) (I) and (III) only (d) (II) and (III) only

13. The bond length of H_2^+, H_2^- and H_2 are in the order

(a) $H_2^+ > H_2 > H_2^-$ (b) $H_2 > H_2^+ > H_2^-$

(c) $H_2^- > H_2 > H_2^+$ (d) $H_2^- > H_2^+ > H_2$

14. Which of the following statement is not correct from the view point of molecular orbital theory?

(a) Be_2 is not a stable molecule.

(b) He_2 is not stable but He_2^+ is expected to exist.

(c) Bond strength of N_2 is maximum amongst the homonuclear diatomic molecules belonging to the second period.

(d) The order of energies of molecular orbitals in N_2 molecule is

$$\sigma 2s < \sigma^* 2s < \sigma 2p_z < (\pi 2p_x = \pi 2p_y) < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$$

15. Which of the following statement is correct about N_2 molecule?

(a) It has a bond order of 3

(b) The number of unpaired electrons present in it is zero and hence it is diamagnetic

(c) The order of filling of MOs is

$$\pi(2p_x) = \pi(2p_y), \sigma(2p_z)$$

(d) All statements are correct

16. The electron probability density Ψ^2_{BMO} is higher than the sum for individual atomic orbitals $(\Psi_A^2 + \Psi_B^2)$ by a factor of

(a) $2\Psi_A$ (b) $2\Psi_B$ (c) $2\Psi_A\Psi_B$ (d) $\Psi_A^2\Psi_B^2$

17. Among the following the one that has two nodal planes is

(a) σ^*_{ns} (b) $\sigma^*_{np_z}$ (c) $\sigma^*_{2p_x}$ (d) σ_{2p_x}

18. The incorrect statement among the following is

(a) In C_2, there is a double bond and both the bonds are π – bonds

(b) Bond order of CO and CO^+ are respectively 3.0 and 3.5

(c) CO, NO^+ and N_2 all have the same bond order value

(d) The B.O of $CO = 2, NO^+ = 2.5$ & $N_2 = 3$

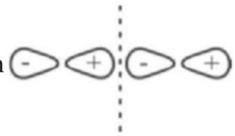
19. Four diatomic species are listed below in different sequences. The correct order of their bond orders is

(a) $C_2^{2-} < He_2^+ < NO < O_2^-$

(b) $He_2^+ < O_2^- < NO < C_2^{2-}$

(c) $O_2^- < NO < C_2^{2-} < He_2^+$

(d) $NO < C_2^{2-} < O_2^- < He_2^+$

20. The diagram  shows:

(a) σ_{ns} (b) σ^*_{ns} (c) σ_{np_z} (d) $\sigma^*_{np_z}$

21. The decreasing order of bond length for N2 and its ions is correctly shown in

(a) $N_2 > N_2^- = N_2^+ > N_2^{2-} = N_2^{2+}$

(b) $N_2^{2-} = N_2^{2+} > N_2^- = N_2^+ > N_2$

(c) $N_2^{2-} > N_2^{1+} > N_2^- > N_2^{2+} > N_2$

(d) $N_2^{2-} > N_2^- > N_2 > N_2^+ > N_2^{2+}$

22. O_2 and N_2 if converted to O_2^+ and N_2^+ respectively. The incorrect statement is

(a) Electron in O_2 goes form $\pi^*_{2p_y}$

(b) Electron in N_2 goes from σ_{2p_z}

(c) Bond length $O-O >$ bond length $(O-O)^+$

(d) Bond length $N-N >$ bond length $(N-N)^+$

23. The common features among the species CN^-, CO and NO^+ are

(a) bond order three and isoelectronic

(b) bond order three and weak field ligands

(c) bond order two and π – acceptors

(d) isoelectronic and weak field ligands

24. What is the effect of the following processes on the bond order in N_2 and O_2?

i) $N_2 \rightarrow N_2^+ + e^-$ ii) $O_2 \rightarrow O_2^+ + e^-$

(a) Decreases in both (i) & (ii)

(b) Increases in both (i) & (ii)

(c) Increases in (i) but decreases in (ii)

(d) Decreases in (i) but increases in (ii)

25. In which set of molecules all the species are paramagnetic ?

(a) B_2, O_2, N_2 (b) B_2, O_2, NO

(c) B_2, F_2, O_2 (d) B_2, O_2, Li_2

26. Among KO_2, AlO_2^-, BaO_2 and NO_2^+, unpaired electron is present in

(a) NO_2^+ and BaO_2 (b) KO_2 and AlO_2^-

(c) KO_2 only (d) BaO_2 only

27. A molecule may be represented by three structures having energies E_1, E_2 and E_3 respectively. The energies of these structures follow the order $E_3 < E_2 < E_1$ respectively. If the experimental energy of the molecule is E_0, the resonance energy is

(a) $(E_1 + E_2 + E_3) - E_0$ (b) $E_0 - E_3$

(c) $E_0 - E_1$ (d) $E_0 - E_2$

ANSWER KEY

1. c	2. c	3. d	4. c	5. d
6. b	7. b	8. a	9. a	10. d
11. b	12. d	13. d	14. d	15. d
16. c	17. c	18. d	19. b	20. d
21. b	22. d	23. a	24. d	25. b
26. c	27. b			

HINTS & SOLUTIONS

3.Sol: According to Pauli's exclusion principle.

5.Sol: He_2 cannot be formed because bond order is zero.

7.Sol: Bonding M.O. has maximum electron density between two nuclei.

10.Sol:

Ions	B.O.
O_2^-	1.5
N_2^+	2.5
F_2	1
H_2^+	0.5

11.Sol:

Ions	B.O.
O_2^-	1.5
O_2	2
O_2^+	2.5

12.Sol: B.O. is directly proportional to the strength of the bond.

13.Sol: Higher is the B.O. lower is the bond length.

17.Sol: ABMO p_x have two nodal planes

19.Sol: Bond orders are : $He_2^+ = 0.5; O_2^- = 1.5;$

$NO = 2.5; C_2^{2-} = 3.0$

21.Sol: Bond order of N_2^{2-} and N_2^{2+} is 2

Bond order of N_2^- and N_2^+ is 2.5

Bond order of N_2 is 3.

23.Sol: CN^-, CO and NO^+ are Isoelectronic $(14\bar{e})$ and has bond order 3.

26.Sol: KO_2 has K^+ and O_2^- structure having one un paired electron.

27.Sol: The difference in energy of the actual molecule (experimental value) and energy of the most stable resonating structure is called resonance energy.

MOCK TEST PAPER

2018 2019

NEET - 5

1. Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of given atomic species?

(a) F < Cl < O < S

(b) S < O < Cl < F

(c) O < S < F < Cl

(d) Cl < F < S < O

2. The pair of amphoteric hydroxides is

(a) $Al(OH)_3, LiOH$

(b) $Be(OH)_2, Mg(OH)_2$

(c) $B(OH)_3, Be(OH)_2$

(d) $Be(OH)_2, Zn(OH)_2$

3. The dipole moment of o,p and m-dichlorobenzene will be in the order

(a) $o > p > m$ (b) $p > o > m$

(c) $m > o > p$ (d) $o > m > p$

4. Between any two of the following molecules, hydrogen bonding is not possible

(a) Two primary amine molecules

(b) Two secondary amine molecules

(c) Two tertiary amine molecules

(d) Two ammonia molecules

5. The common features among the species CN^-, CO *and* NO^+ *are*

(a) Bond order three and isoelectronic

(b) Bond order three and weak field ligands

(c) Bond order two and $\pi-$ acceptors

(d) Isoelectronic and weak field ligands

6. Equal number of moles of CO and CO_2 are filled in a chamber at room temperature. The correct relationship w.r.t their partial pressure P_{CO} and P_{CO_2} is

(a) $P_{CO} > P_{CO_2}$ (b) $P_{CO} < P_{CO_2}$

(c) $P_{CO} = P_{CO_2}$ (d) zero

7. The average speed at temperature $T°C$ of $CH_4(g)$ is $\sqrt{\frac{28}{88}} \times 10^3\ ms^{-1}$. What is the value of T?

(a) $24055°C$ (b) $-32.45°C$

(c) $3000°C$ (d) $-24.055°C$

8. Which of the following behaviour is true regarding the coefficient of viscosity (η) of a liquid?

(a) Plot of η versus T is non linear

(b) Plot of η versus $\frac{1}{T}$ is linear

(c) $\eta = \frac{E}{RT}$

(d) Plot of log η versus $\frac{1}{T}$ is non linear

9. Ionic product of water at 310 K is 2.7×10^{-14}. What is the pH of neutral water at this temperature?

(a) 7 (b) 7.3 (c) 6.3 (d) 6.8

10. The solubility of $Ca(OH)_2$ is $\sqrt{3}$. The solubility product of $Ca(OH)_2$ is

(a) 3 (b) 27 (c) $\sqrt{3}$ (d) $12\sqrt{3}$

11. In the reaction :

$$CS_{2(l)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)};\ \Delta H = -265\ \text{kcal}$$

The enthalpies of formation for both CO_2 and SO_2 are negative and are in the ratio 4 : 3. The enthalpy of formation for CS_2 is + 26 kcal/mol. The enthalpy

of formation for SO_2 is

(a) –90 kcal/mol (b) –52 kcal/mol

(c) –78 kcal/mol (d) –71.7 kcal/mol

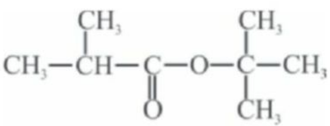
12. Consider the following reaction between zinc and oxygen and choose the correct options out of the options given below :

(a) The enthalpy of two moles of ZnO is less than the total enthalpy of two moles of Zn and one mole of oxygen by 693.8 kJ.

(b) The enthalpy of two moles of ZnO is more than the total enthalpy of two moles of Zn and one mole of oxygen by 693.8 kJ.

(c) 598.3 kJ mol^{-1} energy is evolved in the reaction.

(d) 693.8 kJ mol^{-1} energy is absorbed in the reaction.

13. 

The common name of given ester is

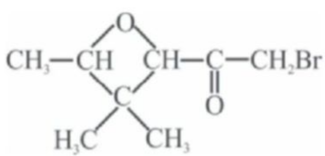
(a) Neo butyl iso butyrate

(b) t-Butyl n- butyrate

(c) t- Butyl iso butyrate

(d) iso butyl iso butyrate

14. IUPAC name of the following compound is



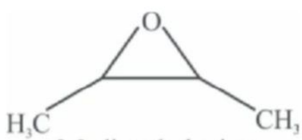
(a) 1-Bromo-3,5-epoxy-4,4-dimethyl-2- hexanone

(b) 1-Bromo-3,3-dimethyl-2-oxo-2-hexanone

(c) 1-Bromo-3,3-dimethyl acetone

(d) 1-Bromo-4,4-dimethyl-5-oxo-hexanone

15. How many geometrical isomers possible for the compound?



2,3-dimethyloxirane

(a) 0 (b) 2 (c) 3 (d) 4

16. The magnetic nature of elements depends on the presence of unpaired electrons. Identify the configuration of transition element, which shows highest magnetic moment?

(a) $3d^7$ (b) $3d^5$ (c) $3d^8$ (d) $3d^2$

17. Railway wagon axles are made by heating rods of iron embedded in charcoal powder. The process is known as

(a) Case hardening (b) Sherardising

(c) Annealing (d) Tempering

18. Gun metal contains

(a) Cu, Sn, Zn (b) Cu, Ni

(c) Cu, Ni, Fe (d) Cu, Sn, P

19. 

Product (C) is

(a) Vinyl chloride (b) Vinyl iodide

(c) Allyl chloride (d) Allyl iodide

20. What amount of bromine will be required to convert 2g of phenol into 2,4,6-tribromophenol?

(a) 10.22 (b) 20.44 (c) 4.00 (d) 6.00

21. Which is lyophobic in nature?

(a) Gelatin (b) Phosphorus

(c) Starch (d) Agar-Agar

22. Which of the following is not a gel?

(a) Cheese (b) Jelly (c) Curd (d) Milk

23. Conductance of 0.1 M KCl (conductivity = X ohm^{-1} cm^{-1}) filled in a conductivity cell is Y ohm^{-1}. If the conductance of 0.1 M NaOH filled in the same cell is Z ohm^{-1}, the molar conductance of NaOH will be

(a) 10^3 XZ/Y (b) 10^4 XZ/Y

(c) 10 XZ/Y (d) 0.1 XZ/Y

24. In the button cell widely used in watches and other devices the following reaction takes place:

$$Zn_{(s)} + Ag_2O_{(s)} + H_2O_{(l)} \rightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2OH^-_{(aq)}$$

Determine $\Delta_r G^o$ for the reaction.

(Given $E^o_{cell} = 1.11$ V)

(a) -2.14×10^4 J (b) -2.14×10^4 kJ

(c) -214 kJ (d) -214 J

25. For a first order reaction $A \rightarrow B$ the reaction rate at which reactant concentration of 0.01 M is found to be 2.0×10^{-5} M sec^{-1}. The half-life period of the reaction is :

(a) 30 s (b) 300 s (c) 220 s (d) 347s.

26. Two substances A and B are present such that $[A]_0 = 4[B]_0$ and half life of A is 5 minute and that of B is 15 minute. If they start decaying at the same time following first order kinetics how much time will the concentration of both of them would be

the same?

(a) 15 minute (b) 10 minute
(c) 5 minute (d) 12 minute

27. M=molarity of the solution
m=molality of the solution
d=density of the solution (in g. ml^{-1})
M^1 = gram molecular weight of solute
Which of the following relations is correct?

(a) $m = \dfrac{M}{1000d - MM^1}$

(b) $m = \dfrac{M \times 1000}{d + MM^1}$

(c) $m = \dfrac{M \times 1000}{(1000 \times d) - MM^1}$

(d) $M = \dfrac{m \times 1000}{(1000 \times d) - MM^1}$

28. X is non volatile solute and Y is a volatile solvent. Following V.P. are observed by dissolving X in Y.

X(M)	0.10	0.25	0.01
Y (mm of Hg)	P_1	P_2	P_3

(a) $P_1 < P_2 < P_3$ (b) $P_3 < P_2 < P_1$
(c) $P_3 < P_1 < P_2$ (d) $P_2 < P_1 < P_3$

29. Equimolal solutions of potassiumhexacyanoferrate (II), (represented as X) and potassium hexacyanoferrate (III), (represented as Y) are considered, which are at equal degree of dissociation. Which of the following statement is correct?

(a) The boiling point of X is greater than Y.
(b) X and Y have the same boiling point.
(c) The boiling point of X is less than Y.
(d) X and Y have the same freezing point.

30. The spin only magnetic moment of $[MnBr_4]^{2-}$ is 5.9BM. The geometry of the complex ion is

(a) Tetrahedral (b) Square planar
(c) Pyramidal (d) Octahedral

31. Which of the following complexes exhibit optical isomerism?

(a) Trans-tetraamminedithiocyanatochromium (III) ion
(b) Cis-diamminedicarbonatacobaltate (III) ion
(c) Trans-diamminedicarbonatacobaltate (III) ion
(d) Cis-bis (glycinato) platinum (II)

32. The bond length of $C-O$ bond in carbon monoxide is $1.28\,\overset{o}{A}$. The $C-O$ bond in $Fe(CO)_5$ is:

(a) $1.15\,\overset{o}{A}$ (b) $1.128\,\overset{o}{A}$ (c) $1.118\,\overset{o}{A}$ (d) $1.72\,\overset{o}{A}$

33. D-Glucose reacts with phenylhydrazine to make osazone. How many molecules of phenylhydrazine are used for this reaction per molecule of D-glucose ?

(a) One (b) Two (c) Three (d) Four

34. Amino acids exist in zwitter ion form. What is the structure of glycine at pH = 4 ?

(a) $H_3N^{\oplus} - CH_2 - COO^-$

(b) $H_3N^{\oplus} - CH_2 - COOH$

(c) $H_2N - CH_2 - COOH$

(d) $H_2N - CH_2 - COO^-$

35. The proteins with a prosthetic group are called

(a) Pseudo proteins (b) Complex proteins
(c) Polypeptides (d) Conjugated proteins

36. Compounds X and Y are obtained by the reaction of Cl_2 with cold and dilute solution of NaOH and compounds X and Z are formed with hot and concentrated solution of NaOH.
The compounds Y and Z respectively are

(a) NaCl, NaClO (b) NaClO, $NaClO_3$
(c) NaCl, $NaClO_3$ (d) NaClO, HCl

37. By adding gypsum to cement

(a) setting time of cement becomes less.
(b) setting time of cement increases.
(c) colour of cement becomes light.
(d) shining surface is obtained.

38. In the carbon family the melting points of the elements decrease on descending the group because the interatomic bonds become:

(a) Stronger as the size of the atom increases
(b) Weaker as the size of the atom decreases
(c) Stronger as the size of the atom decreases
(d) Weaker as the size of the atom increases

39. Carbogen is

(a) Mixture of $90-95\%\ O_2 + 5-10\%\ CO_2$
(b) Used by pneumonia patients for respiration
(c) Used by victims of CO for respiration
(d) All of these

40. Pyrex glass is a mixture of

(a) sodium borosilicate and barium borosilicate
(b) sodium silicate and calcium silicate
(c) sodium silicate and lead silicate
(d) sodium silicate and aluminium borosilicate

41. The number of cis-trans isomers with molecular formula $C_2BrClFI$ is
(a) 4 (b) 6 (c) 7 (d) 8

42. A compound (X) when passed through dil. H_2SO_4 gives compound (Y), which on reaction with HI and red phosphorous gives C_2H_6. The compound (X) is
(a) Ethane (b) Ethyne
(c) 2-Butene (d) 2-Butyne

43. In the reaction of p-chlorotoluene with KNH_2 in liquid NH_3, the major product is
(a) o-Toluidine (b) m-Toluidine
(c) p-Toluidine (d) p-Chloroaniline

44. Aniline on treatment with sodium hypochlorite gives
(a) p-aminophenol (b) phenol
(c) sodium salt of aniline (d) anilinium chloride

45. The compound which on reaction with aqueous nitrous acid at low temperature produces an oily nitrosoamine is
(a) methylamine (b) ethylamine
(c) diethylamine (d) triethylamine

ANSWER KEY

1. c	2. d	3. d	4. c	5. a
6. c	7. b	8. a	9. d	10. d
11. d	12. a	13. c	14. a	15. b
16. b	17. a	18. c	19. c	20. a
21. b	22. d	23. b	24. c	25. d
26. a	27. c	28. d	29. a	30. a
31. b	32. d	33. c	34. b	35. d
36. b	37. b	38. d	39. d	40. a
41. b	42. b	43. b	44. a	45. c

HINTS & SOLUTIONS

3.Sol: Bond angle increases dipole moment decreases.

5.Sol: CN^-, CO and NO^+ are Isoelectronic $\left(14\bar{e}\right)$ and has bond order 3.

6.Sol: They are non-reacting gases.

7.Sol: $\sqrt{\dfrac{8RT}{\pi M}} = \sqrt{\dfrac{28}{88}} = \sqrt{\dfrac{7}{22}}$

$$\frac{8\times 8.314\times T}{\pi\times 16\times 10^{-3}} = \frac{7}{22}\times 10^{6}$$

$$T = \frac{1000\times 2}{8.314} = 240.55K$$

$$T°C = 240.55 - 273 = -32.45°C$$

9.Sol: $K_w = \left[H_3O^+\right].\left[OH^-\right] = 2.7\times 10^{-14}$ at 310K

$$H_2O + H_2O \rightleftharpoons \left[H_3O^+\right]\left[OH^-\right]$$

$$\left[H_3O^+\right] = \left[OH^-\right]$$

Therefore,

$$\left[H_3O^+\right] = \sqrt{2.7\times 10^{-14}} = 1.643\times 10^{-7}\,M$$

$$pH = -\log\left[H_3O^+\right] = -\log 1.643\times 10^{-7}$$

$$pH = 7 + (-0.2156) = 6.7844.$$

10.Sol: $Ca(OH)_2 \rightleftharpoons \underset{s}{Ca^{2+}} + \underset{2s}{2OH^-}$

$$K_{sp} = (s)(2s)^2 = 4s^2, s = \sqrt{3}$$

$$K_{sp} = 4(\sqrt{3})^3 = 12\sqrt{3}$$

11.Sol: $CS_{2(l)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{(g)}$

$$\Delta H = -265 \text{ kcal}$$

$$\Delta H_f^o\left(CO_2,\ g\right) = 4x$$

$$\Delta H_f^o\left(SO_2,\ g\right) = 3x$$

$$\Delta_r H = \sum \Delta_f H^o_{products} - \sum \Delta_f H^o_{reactants}$$

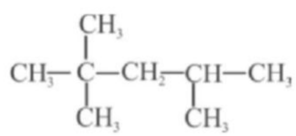
$$-265 = 4x + 6x - 26$$

$$10x = 239$$

$$x = -23.9$$

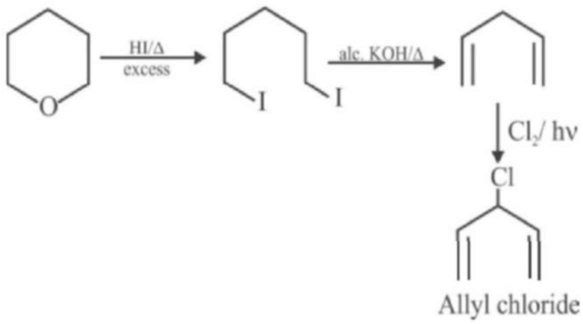
$$\Delta H_f^o\left(SO_2,\ g\right) = -71.7 \text{ kcal/mol}$$

13.Sol: Iso–octane is

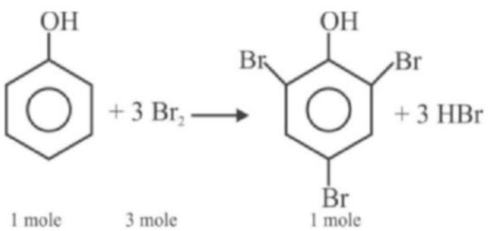


17.Sol: Case hardening: The process of hardening the surface of wrought iron by depositing a surface layer of steel on it is called case-hardening. It is done by heating wrought iron in contact with potassium ferrocyanide.
Alternatively, case hardening can also be done by heating wrought iron with charcoal and then plunging it a suitable oil.

19.Sol:



20.Sol:



94 g of phenol reacts with 480 g of Br_2.

2 g of phenol reacts with $\frac{480}{94}\times 2 = 10.22g$ of Br_2.

23.Sol: Conductivity (X) = conductance × cell constant

Cell constant = X/Y

Conductivity of NaOH = XZ/Y

Λ_m (NaOH) = 10^4 XZ/Y

24.Sol: NH_3 produced due to cathodic reaction,

$MnO_2 + NH_4^+ + e \rightarrow MnO(OH) + NH_3$ combines

With Zn^{2+} to form $Zn(NH_3)_4^{2+}$

25.Sol: rate = $k[A]^1$

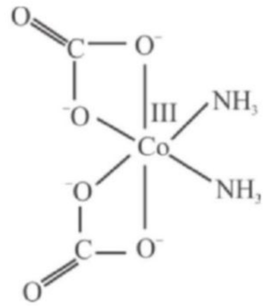
$$k = \frac{2.0\times10^{-5}}{0.01} = 2.0\times10^{-3}$$

$$\therefore\ t_{1/2} = \frac{0.693}{2.0\times10^{-3}} = 347\ s$$

28.Sol: Amount of solute or concentration of the solute increases vapour pressure of volatile solvent decreases.

30.Sol: Since the coordination number of Mn^{2+} ion in the complex ion is 4, it will be either tetrahedral (sp^3 hybridisation) or square planar (dsp^2 hybridisation). But the fact that the magnetic moment of the complex ion is 5.9 BM, it should be tetrahedral in shape rather than square planar because of the presence of five unpaired electrons in the d-orbitals.

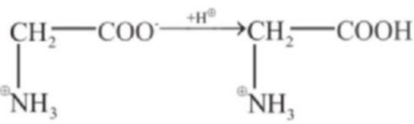
31.Sol:



(Note: CO_3^{2-} acts as bidented in this complex)

32.Sol: Due to synergic bond formation, bond order decreases and bond length increases a little.

34.Sol:



35.Sol: Simple protein and Prosthetic group (non-protein material gives conjugated proteins.

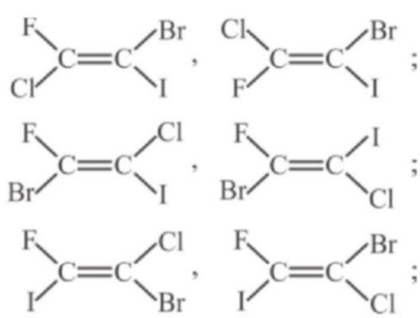
36.Sol: $Cl_2 + 2NaOH \rightarrow 2NaCl + NaClO + H_2O$

(cold dil.) (X) (Y)

$3Cl_2 + 6NaOH(hot) \rightarrow 5NaCl + NaClO_3 + 3H_2O.$

(X) (Y)

41.Sol: Six isomers are :



42.Sol: The compound (X) is likely to be alkyne which reacts with water in the presence of H_2SO_4 and $HgSO_4$ as catalyst to form a carbonyl compound. HI and red phosphorous can reduce a carbonyl compound to alkane having same number of carbon atoms.

Therefore (Y) is likely to be acetaldehyde, which is the hydration product of ethyne.

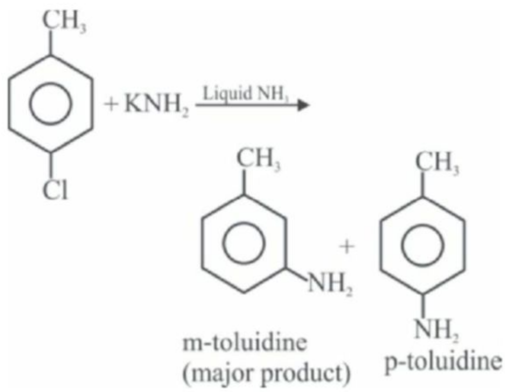
$$\underset{(X)}{HC \equiv CH} + H_2O \xrightarrow[HgSO_4]{H_2SO_4} [CH_2 = CH - OH]$$

$$\rightleftharpoons \underset{(Y)}{CH_3 - CHO}$$

$$CH_3CHO + 4HI \xrightarrow{\text{red P}} CH_3CH_3 + 2I_2 + H_2O$$

Therefore, (X) is ethyne.

43.Sol:



This reaction proceeds through benzyne mechanism.

45.Sol: 2^{o} amine.

QUICK RECAP

For competitive edge

7. EQUILIBRIUM

(1) Chemical equilibrium

- At equilibrium, rate of forward reactions is equal to the rate of backward reaction.
- At equilibrium, concentration of reactant and products remains constant.
- At equilibrium, state $\Delta G = 0$.

(2) Equilibrium Constant (K)

$$aA_{(g)} + bB_{(g)} \rightleftharpoons cC_{(g)} + dD_{(g)}$$

$$\frac{k_f}{k_b} = K = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

(3) Relationship between K_P and K_C

$$K_P = K_C \times (RT)^{\Delta n}$$

$$\Delta n = (c + d) - (a + b)$$

(4) Expressions for K_C and K_P for some reactions

Reaction	K_C	K_P
$mR \rightleftharpoons qP$	$\frac{(n_P)^q}{(n_R)^m} V^{\Delta n}$	$\frac{(n_P)^q}{(n_R)^m}\left[\frac{P}{\sum n}\right]^{\Delta n}$
$H_2(g) + I_2 \rightleftharpoons 2HI(g)$	$\frac{4x^2}{(a-x)(b-x)}$	$\frac{4x^2}{(a-x)(b-x)}$
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	$\frac{4x^2V^2}{(a-x)(b-3x)^3}$	$\frac{4x^2}{P^2(a-x)(b-3x)^3}$
$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$	$\frac{x^2}{(1-x)V}$	$\frac{x^2P}{(1-x^2)}$
$N_2O_4(g) \rightleftharpoons 2NO_2(g)$	$\frac{4x^2}{(1-x)V}$	$\frac{4x^2P}{(1-x^2)}$
$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$	$[CO_2]$	P_{CO_2}

Where, a and b are the initial concetrations of two reactants, and 'x' is the extent of reaction. Σn = Total number of moles at equilibrium and P is the total pressure.

(5) Factors influencing equilibrium constant, K

- Equilibrium constant depends on

(I) Temperature

$$\log\frac{K_2}{K_1}=\frac{\Delta H}{2.303R}\left[\frac{T_2-T_1}{T_1\,T_2}\right]$$

(II) Mode of writing the equation

- For the reactions,

$$A \rightleftharpoons B \qquad B \rightleftharpoons A$$

if $K_C = K$ then $K_C = 1/K$

(III) Stoichiometric coefficients

$$A \rightleftharpoons B \quad 2A \rightleftharpoons 2B \quad \frac{1}{2}A \rightleftharpoons \frac{1}{2}B$$

if $K_C = K$ then $K_C = K^2$ & $K_C = \sqrt{K}$

- $A \rightleftharpoons B \quad B \rightleftharpoons C \quad A \rightleftharpoons C$

if $K_C = K_1$ & $K_C = K_2$ then $K_C = K_1.K_2$

(6) Applications of equilibrium constant, K

(I) Predicting the direction of the reaction

If $Q_C > K_C$ - Backward reaction is favoured.
If $Q_C < K_C$ - Forward reaction is favoured.
If $Q_C = K_C$ - Reaction mixture is at equilibrium.

(II) Predicting the extent of a reaction

If $K_C > 10^3$, products predominate over reactants,
If $K_C > 10^{-3}$, reactants predominate over products,
If K_C is in the range of 10^{-3} to 10^3 appreciable concentrations of both reactants and products are present.

(7) Le Chatelier prinicple

(I) Effect of Concentration

- If concentration of reactants is increased, the equilibrium shifts in forward direction.
- If concentration of products is increased, the equilibrium shifts in backward direction.

(II) Effect of Temperature

- Equilibrium will shift backward in exothermic and forward in endothermic when T is increased.
- Equilibrium will shift forward in exothermic and backward in endothermic when T is decreased.

(III) Effect of Pressure

- Pressure change does not affect the gaseous reaction equilibrium where $\Delta n = 0$, i.e., $n_P = n_R$
- But, when $n_P \neq n_R$, increase in pressure shifts equilbrium in the direction of lower volume or number of moles while decrease in pressure in the direction of higer volume or no. of moles.

(IV) Addition of Catalyst

- Addition of catalyst lowers the activation energy of reaction. It increases rate of both forward and backward reactions to the same extent. Hence, equilbrium is not distrubed but is attained quickly.

(8) Relation between degree of dissociation and vapour density

$$\alpha = \frac{1}{n-1}\left[\frac{D-d}{d}\right]$$

$$\alpha = \frac{No.of\ moles\ dissociated}{Total\ No.of\ moles\ taken}$$

(9) Ionic equilibrium

Ostwald's Dilution Law

$$K_{eq} = \frac{C\alpha^2}{1-\alpha}, \text{ for } \alpha \text{ weak electrolyte } 1-\alpha \cong 1$$

$$K_{eq} = C\alpha^2, \alpha = \sqrt{\frac{K_{eq}}{C}}$$

(10) Ionisation Constant of Water

$K_w = [H^+][OH^-]$ or $K_w = [H_3O^+][OH^-]$

(11) pH scale

- $a_{H^+} = [H^+]\ mol.Lit^{-1}$.
- $pH = \log_{10}\frac{1}{[H^+]}$ (or) $[H^+] = 10^{-pH}$
- $pH + pOH = pK_w$ at any temperature
- At 25° C or 298K for any aqueous solution. $pH + pOH = 14$
- At 25^{0}C for pure water or neutral solution $pH = pOH = 7$.

(12) Calculation of pH of weak acids and weak bases

$pH = -\log [H^+]$ $\qquad$ $pOH = -\log [OH^-]$

$= -\log_{10} [\sqrt{K_a C}]$ $\qquad$ $= -\log_{10} \sqrt{K_b C}$

(13) Salts Hydrolysis

- Salts of strong acids and strong bases do not undergo hydrolysis and the resulting solutions is neutral.

Salt	Hydrolysis	Resulting Solution	Hydrolysis constant (K_h)	Degree of hydrolysis (h)	pH
Weak acid and strong base	Anionic	Alkaline pH>7	$K_h = \frac{K_w}{K_a}$	$h = \sqrt{\frac{k_h}{C}}$	$pH = \frac{1}{2}[pK_w + pK_a + \log C]$
Strong acid and Weak base	Cationic	Acidic pH<7	$K_h = \frac{K_w}{K_b}$	$h = \sqrt{\frac{k_h}{C}}$	$pH = \frac{1}{2}[pK_w - pK_b - \log C]$
Weak acid and Weak base	Anionic and cationic both	Neutral pH=7 (If K_a=K_b)	$K_h = \frac{K_w}{K_a K_b}$	$h = \sqrt{k_h}$	$pH = \frac{1}{2}[pK_w + pK_a - pK_b]$

(14) Buffer solutions

(I) Henderson - Hasselbalch equation

(i) pH of Acid Buffer

Mixture of $CH_3COOH + CH_3COONa$ is an acid buffer.

$$pH = pK_a + \log\frac{[Salt]}{[Acid]}$$

(ii) pH of Basic Buffer

Mixture of $NH_4OH + NH_4Cl$ is a basic buffer.

$$\Rightarrow pOH = pK_b + \log\frac{[Salt]}{[Base]}$$

pH of buffer after adding H^+ =

$$pK_a + \log\frac{[Salt - x]}{[Acid + x]}$$

using AAA rule pH of buffer decreases.

(II) Buffer capacity or Buffer Index (ϕ)

The ability of the buffer to resist changes in pH.

(15) Solubility Product

- $A_xB_y \rightleftharpoons xA^{y+} + yB^{x-}$

$$K_{sp} = [A^{y+}]^x[B^{x-}]^y$$

Let the solubility of A_xB_y is S then

$$K_{sp} = [xS]^x[yS]^y \Rightarrow K_{sp} = x^x.y^y[S^{x+y}]$$

$$S^{x+y} = \frac{K_{sp}}{x^x\ y^y} \text{ then } \boxed{S = \sqrt[x+y]{\frac{K_{sp}}{x^x\ y^y}}}$$

- *Ionic product and Solubility product*

i) Ionic product = K_{SP} - This is Saturated solution.

ii) Ionic product < K_{SP} - This means the solution is unsaturated and more salt can be dissolved in it.

iii) Ionic product > K_{SP} - This means solution is holding more salt than it can dissolve in.

8. REDOX REACTIONS

(1) Oxidation and Reduction reactions

(I) Oxidant or oxidising agent

Species, which oxidise other species, which is present in a reaction and reduce itself.

Some Important oxidising agent or oxidant

- All elements with high electronegative character like N, O, F, Cl, etc.
- All metallic oxides like $Li_2O, Na_2O, Na_2O_2, CO_2, CaO, MgO, BaO_2$ etc.
- Some nonmetallic oxides like CO_2, SO_2, H_2O_2, O_3.
- All neutral compound or ion in which element shows their higher oxidation no. or state are act as oxidant or oxidising agent

(II) Reductant or Reducing agent

Species which reduce other element in a reaction and oxidise itself to donate electrons and show increase in its oxidation no. is called reductant or reducing agent.

Some Important reducing agents or reductants

- All metals like, K, Mg, Ca, etc.
- All metallic hydrides like $NaH, CaH_2, LiAlH_4, NaBH_4, AlH_3$, etc.

- All hydroacids like HF, HCl, HBr, H_2S etc.
- Some organic compounds like aldehyde, formic acid, oxalic acid, tartaric acid.
- All neutral compounds or ions, which show their lower oxidation state.

(2) Oxidation number

- It represents the number of electron gained or lost by atom when it changes in compound from a free state.
- Maximum oxidation no. of an element is equal to group no. in the periodic table
- Minimum oxidation no. of an element is equal to group no. – 8

(3) Oxidation state

Oxidation state of an atom is defined as oxidation number per atom for all practical purposes.

- ***The rules to derive oxidation number or oxidation state are as follows***
- The O.S. of an element in its free state is zero. Example O.S.' s of Na, Cu, I_2, Cl_2, O_2 etc. are zero
- Sum of O.S.' s of all the atoms in neutral molecule is zero.
- Sum of O.S.' s of all the atoms in a complex ion is equal number of charge present on it.
- In complex compounds, O.S. of some neutral molecules (ligands) is zero. Example CO, NO, NH_3, H_2O.
- Generally O.S. of oxygen is –2 but in H_2O_2 it is –1 and in O_2F_2 it is +1, in OF_2 it is +2.
- Generally O.S. of Hydrogen is +1 but in metallic hydrides it is –1.
- Generally O.S. of halogen atoms is –1 but in interhalogen compounds it changes.

(4) Redox Reactions

(I) The reactions in which oxidation and reduction both occur simultaneously are called redox reactions.

(II) Any redox reaction may be divided in two parts:

(i) Oxidation half reaction

(ii) Reduction half reaction

(5) Types of redox reactions

(I) Intermolecular redox reaction

$$2H_2\overset{+6}{S}O_4(conc.) + \overset{0}{C}u \rightarrow \overset{+2}{Cu}SO_4 + \overset{+4}{S}O_2 + 2H_2O$$

(II) Intramolecular redox reaction

$$2K\overset{+5}{Cl}\overset{-2}{O_3} \rightarrow 2K\overset{-1}{Cl} + 3\overset{0}{O_2}$$

(III) Disproportion Redox Reaction

In this type of redox reactions same element acts as both oxidising & reducing agent.

$$\overset{0}{Cl_2} + H_2O \rightarrow H\overset{+1}{Cl}O + H\overset{-1}{Cl}$$

(6) Balancing redox reactions

(I) Half reaction method

consider the example,

$$Cr_2O_7^{2-} + C_2O_4^{2-} \xrightarrow{H^+} Cr^{3+} + CO_2$$

(i) Write both the half reactions.

$Cr_2O_7^{2-} \rightarrow Cr^{3+}$ (Reduction half reaction)

$C_2O_4^{2-} \rightarrow CO_2$ (Oxidation half reaction)

(ii) Atoms other than H and O are balanced

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

$$C_2O_4^{2-} \rightarrow 2CO_2$$

(iii) Balance O–atoms by the addition of H_2O to another side

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$$

$$C_2O_4^{2-} \rightarrow 2CO_2$$

(iv) Balance H–atoms by the addition of H^+ ions to another side

$$Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$$

$$C_2O_4^{2-} \rightarrow 2CO_2$$

(v) Now, balance the charge by the addition of electrons (e^-).

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$$

(vi) Multiply equations by a constant to get number of electrons same in both side. In the above case second equation is multiplied by 3 and then added to first equation.

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

$$3C_2O_4^{2-} \rightarrow 6CO_2 + 6e^-$$

$$\overline{Cr_2O_7^{2-} + 3C_2O_4^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 6CO_2 + 7H_2O}$$

In Alkaline medium

Consider the reaction

$$Cr(OH)_3 + IO_3^- \xrightarrow{OH^-} I^- + CrO_4^{2-}$$

(i) Separate the two half reactions.

$Cr(OH)_3 \rightarrow CrO_4^{2-}$ (Oxidation half reaction)

$IO_3^- \rightarrow I^-$ (Reduction half reaction)

(ii) Balance O– atoms by adding H_2O.

$H_2O + Cr(OH)_3 \rightarrow CrO_4^{2-}$,

$IO_3^- \rightarrow I^- + 3H_2O$

(iii) Balance H–atoms by adding H_2O to side having deficiency and OH^- to other side having deficiency of H–atoms.

$5OH^- + H_2O + Cr(OH)_3 \rightarrow CrO_4^{2-} + 5H_2O$ or

$5OH^- + Cr(OH)_3 \rightarrow CrO_4^{2-} + 4H_2O$

$IO_3^- + 6H_2O \rightarrow I^- + 3H_2O + 6OH^-$ or

$IO_3^- + 3H_2O \rightarrow I^- + 6OH^-$

(iv) Balance the charges by electrons

$5OH^- + Cr(OH)_3 \rightarrow CrO_4^{2-} + 4H_2O + 3e^-$

$IO_3^- + 6H_2O + 6e^- \rightarrow I^- + 3H_2O + 6OH^-$

(v) Multiply first equation by 2 and add to second to give

$10OH^- + 2Cr(OH)_3 \rightarrow 2CrO_4^{2-} + 8H_2O + 6e^-$

$IO_3^- + 6H_2O + 6e^- \rightarrow I^- + 3H_2O + 6OH^-$

$4OH^- + 2Cr(OH)_3 + IO_3^- \rightarrow 5H_2O + 2CrO_4^{2-} + I^-$

(II) Oxidation number method

(i) Write the skeleton equation (if not given, frame it) representing the chemical change.

(ii) Assign oxidation numbers to the atoms in the equation and find out which atoms are undergoing oxidation and reduction. Write separate equations for the atoms undergoing oxidation and reduction.

(iii) Find the change in oxidation number in each equation. Make the change equal in both the equations by multiplying with suitable integers. Add both the equations.

(iv) Complete the balancing by inspection. First balance those substances which have undergone change in oxidation number and then other atoms except hydrogen and oxygen. Finally balance hydrogen and oxygen by putting H_2O molecules wherever needed.

The final balanced equation should be checked to ensure that there are as many atoms of each element on the right as they are on the left.

9. HYDEOGEN

(1) Hydrogen

(I) Resemblance with alkali metals due to

- Electronic configuration $(ns^1) : 1s^1$ i.e., it has one electron in s - orbital of valence shell
- Oxidation state $(+1) : H^+Cl, Na^+Cl$

(II) Resemblance with halogens due to

- Electronic configuration: One electron less than the nearest inert gas configuration
- Electronegative character: Both have tendency to accept one electron to form anions
- Ionisation energy: Comparable with halogens.

(III) Differences from alkali metals and halogens

- Less electropositve than alkali metals and less electronegative than halogens
- Size of ions: H^+ is much smaller than alkali metal ions and H^- is much larger than halide ions.

(2) Preparation of di hydrogen (H_2)

- $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
- $CaH_2 + 2H_2O \xrightarrow{Fe_2O_3 \text{ or } Cr_2O_3} Ca(OH)_2 + 2H_2$.
- $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$
- $2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

  (Uyeno's method)
- $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
- $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$

(3) Chemical Properties of dihydrogen

- $2Na + H_2 \rightarrow 2NaH$
- $H_2 + X_2 \rightarrow 2HX$
- *Reducing nature*

$$Fe_3O_4 + 4H_2 \rightarrow 3Fe + 4H_2O$$

Unsaturated fat $+H_2 \xrightarrow{Ni}$ Saturated fat

(Oil) (Vanaspati Ghee)

(4) Different forms of H_2

(I) Nascent Hydrogen

(II)Adsorbed Hydrogen

(III)Atomic Hydrogen

(IV)Ortho and Para hydrogen

(i) Ortho hydrogen: Spin of protons or nucleii are in same direction ortho hydrogen

(ii) Para hydrogen: Spin of protons or nucleii are in opposite direction.

(5) Hydrides

(I) Ionic hydrides or Saline hydrides

(II) Covalent hydrides or Molecular hydrides

(III) Metallic or Interstitial hydrides

(IV) Polymeric hydrides

(6) Hydrogen Peroxide

(I) Methods of preparation

$$BaO_2 + CO_2 + H_2O \rightarrow H_2O_2 + BaCO_3$$

$$Na_2O_2 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O_2$$

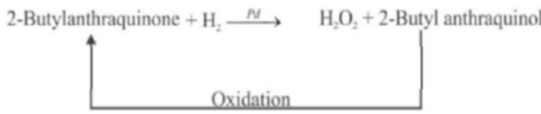
By electrolysis of 50% H_2SO_4 at 0°C using Pt electrode.

$$2H_2SO_4 \rightarrow 2H^+ + 2HSO_4^-$$

At cathode (Cu): $2H^+ + 2e^- \rightarrow H_2$

At anode (Pt): $2HSO_4^- \rightarrow H_2S_2O_8 + 2e^-$

$$H_2S_2O_8 + 2H_2O \rightarrow H_2O_2 + 2H_2SO_4$$



(II) Physical Properties

- Pure H_2O_2 is weak acidic in nature and exists as associated liquid due to hydrogen bonding.
- Smell of H_2O_2 resembles like nitric acid.
- It causes blisters on skin.
- A dilute solution of H_2O_2 is concentrated by vacuum distillation or by distillation under pressure.

(III) Chemical Properties

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

$$PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$$

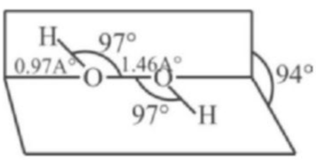
$$K_2Cr_2O_7 + H_2SO_4 + 4H_2O_2 \rightarrow 2CrO_5 + K_2SO_4 + 5H_2O$$

$$2K_3[Fe(CN)_6] + 2KOH + H_2O_2 \rightarrow 2K_4[Fe(CN)_6] + 2H_2O + O_2$$

(7) Strength of H_2O_2

Sample of H_2O_2	% strength (w/v)	Molarity, M	Normality, N
5.6 vol. H_2O_2	1.7% w/v	0.5 M	1 N
11.2 vol. H_2O_2	3.4% w/v	1 M	2 N
22.4 vol. H_2O_2	6.8% w/v	2 M	4 N
10 vol. H_2O_2	3% w/v	0.89 M	1.78 N
100 vol. H_2O_2	30% w/v	8.9 M	17.8 N

(8) Structure of H_2O_2



(9) Soft water and Hard water

- Water which gives foam easily with soap is known as soft water. The other which gives with difficulty is known as hard water.
- Hardness of water is of two types

(I) Temporary hardness

(i) Due to soluble bicarbonates of Ca and Mg

(ii) It can be removed by boiling or adding

calculated quantity of slaked lime.

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + H_2O + CO_2$$

Clark's method

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$$

(II) Permanent hardness

- Due to soluble sulphates, chlorides, nitrates of Ca and Mg.
- It can be removed
  (i) By Permutit Process:
  (ii) By washing soda (Na_2CO_3):

$$MgCl_2 + Na_2CO_3 \rightarrow MgCO_3 + 2NaCl$$

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$$

(iii) Calgon's method:
Sodium hexametaphosphate

$$M^{2+} + Na_4P_6O_{18}^{2-} \rightarrow [Na_2MP_6O_{18}]^{2-} + 2Na^+ (M = Mg, Ca)$$

(iv)Synthetic resins method:

$$2RNa(s) + M^{2+}(aq) \rightarrow R_2M(s) + 2Na^+(aq)$$

$$2RH(s) + M^{2+}(aq) \rightleftharpoons MR_2(s) + 2H^+(aq).$$

$$RNH_2(s) + H_2O(l) \rightleftharpoons RNH_3^+.OH^-(s)$$

$$RNH_3^+.OH^-(s) + X^-(aq) \rightleftharpoons RNH_3^+.X^-(s) + OH^-(aq)$$

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

10. S-BLOCK ELEMENTS (ALKALI & ALKALINE EARTH METALS)

(1) Alkali metals

- The elements lithium (Li), sodium (Na), potassium (K), rubidium (Rb), caesium (Cs) and francium (Fr), constitute group 1 of the periodic table.

(2) Alkaline Earth Metals

- The elements of group 2 are beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr),barium (Ba) and radium (Ra).

(3) Atomic and Physical properties of s - block elements

Property	Alkali metal	Alkaline earth metal
Atomic and Ionic radii	• The atoms of alkali metals have the largest size in their respective periods. The atomic radii increase on moving down the group among the alkali metals	• The atomic radii as well as ionic radii of the members of the family are smaller than the corresponding members of alkali metals.
Ionisation Energy	• I.P. of these metals decreases from Li to Cs	• The I.P. values decreases with increase of atomic radii from Be to Ba
Electronegativity	• Electronegativity of alkali metals decreases down the group	• Electronegativity decrease from Be to Ba
Density	• Li is lightest known metal among all • K is lighter than Na because of low density	• Density of Mg is greater than Ca
Flame colour	• Characteristic flame colours are Li-crimson, Na-Golden yellow, K-pale violet, Rb and Cs-violet.	• Be and Mg do not show any colour as their electrons are more strongly bound. • Ca-Brick red, Sr-Crimson Ba-apple green
Hydration of ions	• Smaller the cation greater is the degree of hydration. Hydration energy order is $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$	• Hydration energy order is $Be^{+2} > Mg^{+2} > Ca^{+2} > Sr^{+2} > Ba^{+2}$
Standard oxidation potential and reducing properties	• Li have greatest reducing nature due to maximum hydration energy of Li^+ ion	• Standard oxidation potentials are Be Mg Ca Sr 1.69 2.35 2.87 2.90

(4) Chemical properties of s-block elements

Property	Alkali metal	Alkaline earth metal
Action with air	• They generally form oxides and peroxides. $M + O_2 \longrightarrow \underset{\text{Oxide}}{M_2O} \xrightarrow{O_2} \underset{\text{Peroxide}}{M_2O_2}$	• They give oxides of ionic nature $M^{+2}O^{-2}$ which are crystalline in nature.
Action with water	$2M + 2H_2O \longrightarrow 2MOH + H_2$	$M + 2H_2O \longrightarrow M(OH)_2 + H_2$
Hydrides	• The tendency to form their hydrides decreases from Li to Cs, since the electropositive character decreases from Cs to Li.	• The stability of hydrides decreases from Be to Ra
Carbonates and bicarbonates	$Li_2CO_3 \longrightarrow Li_2O + CO_2$ $2MHCO_3 \xrightarrow{300^\circ C} M_2CO_3 + H_2O + CO_2$	$M(HCO_3)_2 \xrightarrow{\Delta} MCO_3 + CO_2 + \underset{\text{(Solution)}}{H_2O}$
Nitrates	$2MNO_3 \rightarrow 2MNO_2 + O_2$ (except Li) $4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$	$M(NO_3)_2 \rightarrow MO + 2NO_2 + \frac{1}{2}O_2$
Solubilities in Liq NH_3	$Na \rightleftharpoons \underset{\text{(Ammoniated)}}{Na^+ (\text{in Liq } NH_3) + e^-}$ $M + (x+y)NH_3 \rightarrow [M(NH_3)_x]^+ + e^-(NH_3)_y$ (solvated electron)	• When such a solution is evaporated, hexammoniate, $M(NH_3)_6$ is formed.
Basic nature of hydroxide	$LiOH < NaOH < KOH < RbOH < CsOH$	$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

(5) Diagonal relationship between Lithium and Magnesium

- The carbonates of lithium and magnesium decompose easily on heating to form the oxides and CO_2.
- Both $LiCl$ and $MgCl_2$ are soluble in ethanol
- Both $LiCl$ and $MgCl_2$ are deliquescent and crystallise from aqueous solution as hydrates, $LiCl.2H_2O$ and $MgCl_2.8H_2O$

(6) Diagonal relationship between Be and Al

- Compounds of Be like those of Al undergo hydrolysis.

  $BeCl_2 + 2H_2O \rightarrow Be(OH)_2 + 2HCl$

  $AlCl_3 + 3H_2O \rightarrow Al(OH)_3 + 3HCl$
- Be forms complex anions (beryllates like aluminium forms aliminates, while other alkaline earth metals do not form complex anions.

  $Be + 2NaOH \rightarrow Na_2BeO_2 + H_2 \uparrow$

  $2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2 \uparrow$
- Beryllium and aluminium ions have strong tendency to form complexes BeF_4^{2-}, AlF_6^{3-}.

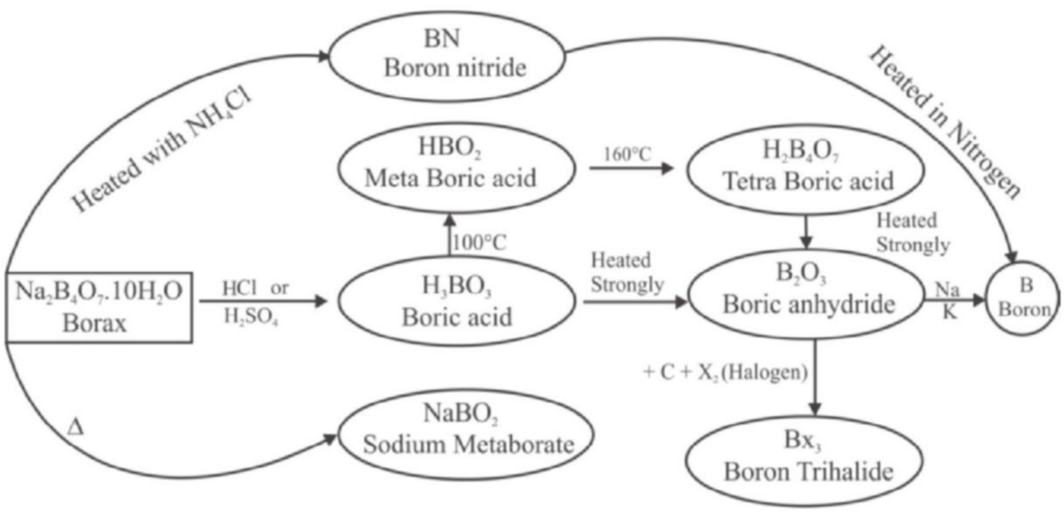
11. p-BLOCK ELEMENTS

(1) Group - 13 elements

- B, Al, Ga, In, and T*l* belongs to group - 13 elements
- General electronic configuration is $\mathbf{ns^2np^1}$
- Atomic radius increases suddenly from B to Al
  The atomic radii of Ga is less than Al. This is because of the poor shielding effect of d-electrons in Gallium.
- The order of ionization enthalpy is $B > Tl > Ga > Al > In$
- The common oxidation state of these elements is +3
- Amorphous boron and aluminium metal on heating in air form B_2O_3 and Al_2O_3 respectively.

$$2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2AlCl_{3(aq)} + 3H_{2(g)}$$

$$2Al_{(s)} + 2NaOH_{(aq)} + 6H_2O_{(l)} \rightarrow \underset{\text{Sodium tetrahydoxoaluminate(III)}}{2Na[Al(OH)_4]_{(aq)}} + 3H_{2(g)}$$



(2) Carbon family

- Carbon, Silicon, Germanium, Tin and Lead are IV A group elements.
- The general outer electronic configuration of IV A group elements is $\mathbf{ns^2\ np^2}$.
- The number of electrons present in the penultimate shell of carbon is 2, Si is 8 while Ge, Sn, Pb contain 18 electrons each.
- Covalent radius increases considerably from C to Si there after small increase is observed up to Pb due to completely filled d and f orbitals.
- IP_1 & IP_2 order is $\mathbf{C > Si > Ge > Pb > Sn}$
- The order of catenating power in IV A group elements is $\mathbf{C >> Si > Ge > Sn > Pb}$.
- Common oxidation state of IV A group elements are +2, +4.
- When heated in oxygen form two types of oxides.
  Monoxide (**MO**) Dioxide ($\mathbf{MO_2}$)
  C, Si, Ge are unaffected by water.
- Sn reacts with steam to give SnO_2 and H_2.

$$\mathbf{Sn + 2H_2O \xrightarrow{\Delta} SnO_2 + 2H_{2(g)}}$$

Pb is not affected by H_2O due to an oxide layer onthe surface.

- Reaction with acids and base:

$$\mathbf{4Sn + 10HNO_3 \rightarrow 4Sn(NO_3)_2 + NH_4NO_3 + 3H_2O}$$

$$\mathbf{3Pb + 8HNO_3 \rightarrow 3Pb(NO_3)_2 + 2NO + 4H_2O}$$

$$\mathbf{Si + 2NaOH + H_2O \rightarrow \underset{\text{Sodium Silicate}}{Na_2SiO_3} + 2H_2}$$

- The thermal stability of tetrahalides decreases in the order

$$CX_4 > SiX_4 > GeX_4 > SnX_4 > PbX_4$$

Thermal stability order of hydrides :

$$CH_4 > SiH_4 > GeH_4 > SnH_4 > PbH_4$$

(3) Silicones

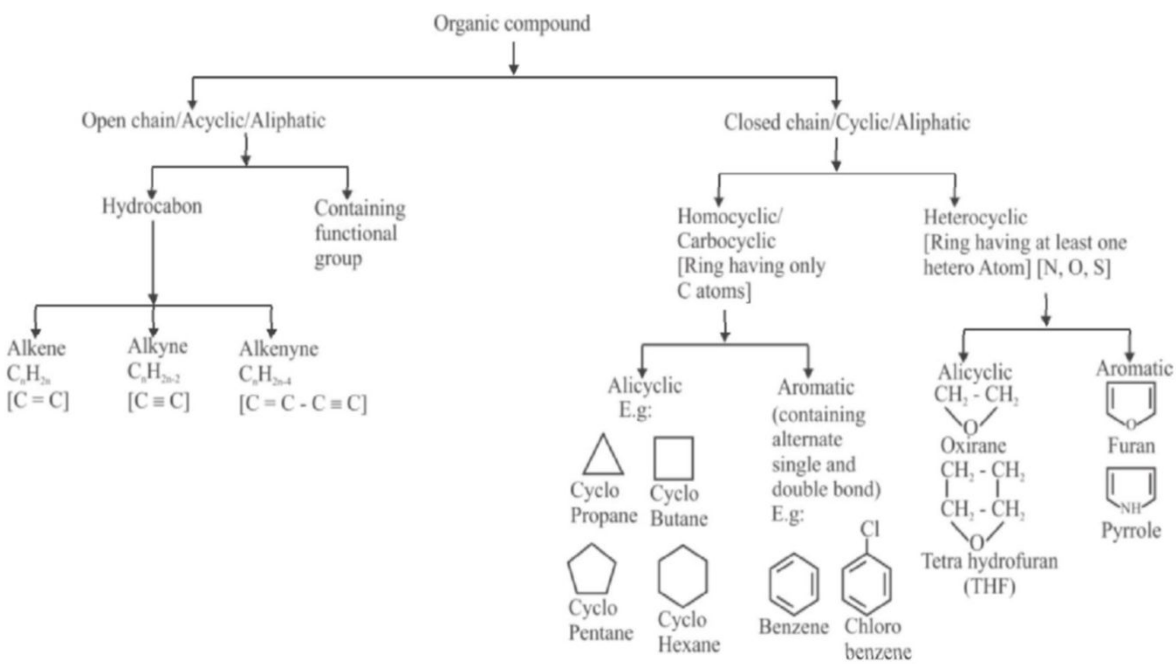
- Silicones are Organo Silicon polymers containing Si – O – Si bonds.
  Polymerisation of dialkyl silane diols yield linear thermoplastic polymers.
- Cyclic or ring silicones are formed when water is eliminated from terminal –OH groups of linear silicones.
- Hydrolysis of $RSiCl_3$ gives crosslinked silicones. Commercial silicone polymers are usually methyl derivatives and to a lesser extent phenyl derivatives.

(4) Silicates

- Silicates are the metal derivatives of silicic acid H_4SiO_4 or $Si(OH)_4$.
- The basic structural unit in silicates is the **SiO_4^{4}**, a tetrahedron.
- Depending on the number of corners 0,1,2,3 or 4 of **SiO_4^{4-}** shared various kinds of silicates are formed.

12. ORGANIC CHEMISTRY (SOME BASIC PRINCIPLES & TECHNIQUES)

(1) Classification of organic compounds



- A group of organic compounds which show similar properties but differ from the preceding or succeeding member by one $-CH_2-$ (methylene) unit is known as Homologous series. The different members of a homologous series are called **homologues** and the phenomenon is called **homology**.

(2) Nomenclature Of Organic Compounds

- *IUPAC nomenclature*

Nomenclature according to IUPAC system involves use of following terms

2^0 Prefix+1^0 Prefix+ Root Word +1^0Suffix+2^0Suffix

(I) Root Word

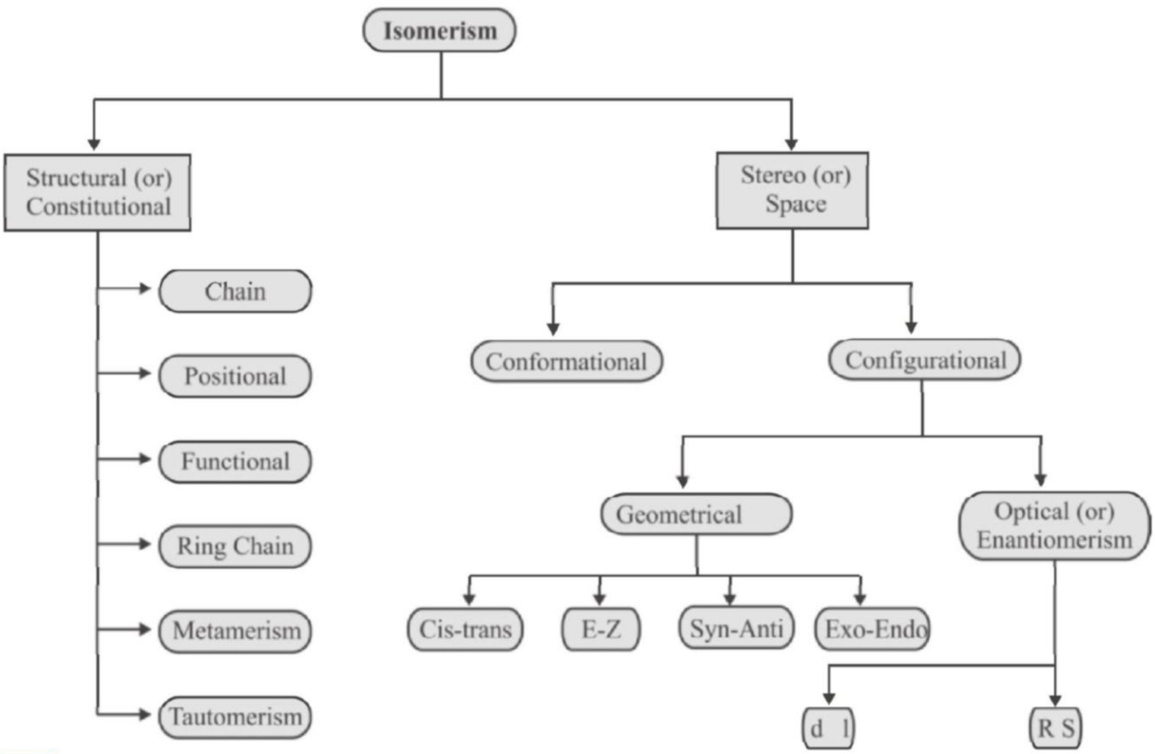
The root word represents the number of C atoms in parent chain.

No. of C's	Root Word	No. of C's	Root Word
1	Meth	11	Undec
2	Eth	12	Dodec
3	Prop	13	Tridec
4	But	14	Tetradec
5	Pent	20	Eicos
6	Hex	30	Triacont
7	Hept	40	Tetracont
8	Oct	50	Pentacont
9	Non	60	Hexacont
10	Dec	100	Hect/Cent

(II) Suffix

GF & Common name	Suffix	IUPAC Name	Prefix
R-OH Alcohols	ol	Alkanol	Hydroxy
R-SH Thioalcohols	Thiol	Alkanethiol	Mercapto
$R\text{-}NH_2$ Amines	Amine	Alkanamine	Amino
R-CHO Aldehydes	al	Alkanal	Formyl
RCO Ketones	one	Alkanone	Keto or oxo
RCOOH Carboxylic acids	oic acid	Alkanoic acid	Carboxy
RCONH2 Amides	amide	Alkanamide	Carbamoyl
RCOX Acid halides	oyl halide	Alkanoyl halide	haloformyl
RCOOR Esters	oate	Alkyl alkanoate	Carbalkoxy
RCN Nitriles	nitrile	Alkane nitrile	Cyano
RNC Isonitriles	isonitrile	Alkane isonitrile	Carbylamino

(3) Isomerism



(4) Fission or breaking of a covalent bond

The covalent bond is broken equally such that each of the bonded atoms retain their electron used in bonding. This leads to the formation of odd electron species known as **free radical**.

The covalent bond is broken unequally such that only one of the bonded atoms gets both the electrons resulting in the formation of positive and negative charged species.

(5) Attacking reagents

I. Electrophiles or Electrophilic reagents.

II. Nucleophiles or Nucleophilic reagents.

atom has unfilled d-sub shells.

(6) Electron displacement effects in organic molecules

(I) Inductive effect:

The polarization of a σ bond due to electron withdrawing or electron donating effect of adjacent groups or atoms is called inductive effect. The decreasing order of -I effect :

$$NR_3^+ > NH_3^+ > NO_2 > CN > SO_3H > COOH >$$
$$F > Cl > Br > I > OR > NR_2 > C_6H_5 > H$$

(R = H, alkyl, aryl, acyl)

The decreasing order of +I effect :

$$:\ddot{O}^{-} > -\underset{3^0}{C}R_3 > -\underset{2^0}{C}HR_2 > -\underset{1^0}{C_3}H_7 > -\underset{1^0}{C_2}H_5 > -CH_3 > H$$

❍ Applications of Inductive Effect:

(i) Stability of carbonium ions:

The order of stability of carbonium ions is

$3^o > 2^o > 1^o >$ Methyl

(ii) Stability of carbanions :

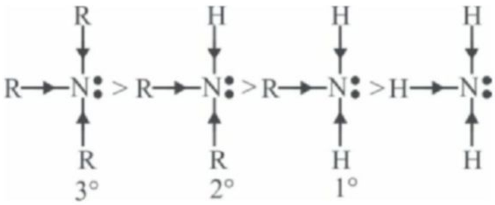
Methyl $> 1^o > 2^o > 3^o$

(iii) **Acidic strength of Carboxylic acids:**

EWG (-I) increases the acidic strength.

However, the EDG (+I) groups decrease the acidic strength.

(iv) Basicity of Amines : **(+I) groups (EDG) increase the basic nature of amines**, whereas (-I) groups (EWG) decrease the basic strength of amines.



(II) Electromeric effect:

The electronic system of an unsaturated molecule is deformed when the reagent approaches close to it. When the reagent is removed without allowing the reaction to takes place, the electronic system reverts to the original state of the molecule.

This kind of polarisation of multiple bonds is known as electromeric effect.

(III) Mesomeric effect:

Permanent polarisation in a compound due to delocalisation of π - e^-s along the conjugated systems caused by an atom or group in conjugation is called mesomeric effect

+M Effect atoms or groups

$$-NH_2, -NHR, -NR_2, -OH, -OR,$$
$$-SR, -X(X = Cl, Br, I)$$

(IV) Hyperconjugation or No bond resonance or Baker Nathan effect:

The delocalization of σ -electrons of C—H bond of an alkyl group into adjacent empty (or partially filled) non bonding p-orbital of carbon of a double bond or a carbocation or a free carbon radical is called hyperconjugation.

(7) Reaction intermediates

Property	Carbocation	Carbanion	Carbon free radical
Representation	$>C^{\oplus}$	$>\overset{\ominus}{C}$	$>\dot{C}$
Bond fission	Heterolysis	Heterolysis	Homolysis
Electricity nature	Positive	Negative	Neutral
No. of electrons in valence shell	6	8	7
Hybridisation	sp^2	sp^3	sp^2
Shape	Planar	Pyramidal	Planar

(8) Purification of organic compounds

(I) Sublimation

- The organic compounds such as benzoic acid, naphthalene, anthracene, camphor, indigo, anthraquinone etc., are purified by this process

(II) Crystallisation

(i) Simple Crystallisation:

- *It is based on the fact that all organic compounds are more soluble in hot than in* cold solvents, so that solid gets dissolved on heating and is obtained back on cooling.

E.g:

- Sugar having an impurity of common salt can be crystallised from hot ethanol since sugar dissolves in hot ethanol but common salt does not.

(ii) Fractional Crystallisation:

- The process of separation of different components of a mixture by repeated crystallisation is called fractional crystallisation.
- Fractional crystallisation can be used to separate a mixture of $KClO_3$ (less soluble) and KCl (more soluble).

(III) Simple distillation:

- For example, chloroform ($CHCl_3$) and aniline can be separated by simple distillation because of the large difference in their boiling points. Boiling point of ($CHCl_3$) is 60° and boiling point of aniline is 189°C. Ether (B.P. 308K) and toulene (B.P. 384K) can be separated by this method.

(IV) Fractional distillation

This method may be used to separate a mixture of acetone (b.p. 330K) and methyl alcohol (b.p. 338. K).

(V) Distillation under reduced pressure

Certain liquids have a tendency to decompose at a temperature below their boiling points. Such liquids cannot be purified by ordinary distillation.

E.g: glycerol boils with decomposition at 563K.

(VI) Steam distillation

Chromatography

- This technique is very useful for the separation, isolation, purification, and identification of the constituents of a mixture.

(i) Adsorption Chromatography

(A) Column Chromatography:

(B) Thin layer chromatography:

(ii) Partition chromatography

(9) Characterisation Of The Organic Compound

Qualitative analysis (Detection of elements)

- **Detection of Carbon and Hydrogen**

Element	Detection	Confirmatory test	Reaction
Carbon	Copper (II) oxide test $2CuO + C \xrightarrow{\Delta} 2Cu + CO_2\uparrow$	CO_2 gas turns lime water milky	$\underset{\text{Lime water}}{CO_2 + Ca(OH)_2} \longrightarrow \underset{\text{Milkiness}}{CaCO_3} + H_2O$
Hydrogen	$CuO + 2H \xrightarrow{\Delta} Cu + H_2O$	Water droplets appear on the cooler part of the ignition tube and also turns anhydrous $CuSO_4$ blue.	$\underset{\text{White}}{CuSO_4} + 5H_2O \longrightarrow \underset{\text{Blue}}{CuSO_4.5H_2O}$

- **Detection of Phosphorus**

Element	Detection	Confirmatory test	Reaction
Phosphorus	$P \xrightarrow[\Delta]{Na_2O_2,\ boil} Na_3PO_4$	Solution is boiled with nitric acid and then treated with ammonium molybdate $(NH_4)_2MoO_4$. Formation of yellow ppt. indicates the presence of phosphorus in organic compound.	$Na_3PO_4 + 3HNO_3 \rightarrow H_3PO_4 + 3NaNO_3$ $H_3PO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \rightarrow \underset{\text{Ammonium phosphomolybdate (yellow ppt)}}{(NH_4)_3PO_4.12MoO_3} + 21NH_4NO_3 + 12H_2O$

Detection of N, S and Halogens

N, S, and halogens present in an organic compound are detected by "Lassaigne's test".

Element	Detection	Confirmatory test	Reaction
Nitrogen	Lassaigne's extract (L.E.) $Na + C + N \xrightarrow{\Delta} \underset{(L.E.)}{NaCN}$	L.E. + $FeSO_4$ + NaOH, boil and cool + $FeCl_3$ + conc. HCl $\longrightarrow$ blue or green colour.	$FeSO_4 + 2NaOH \longrightarrow Fe(OH)_2 + Na_2SO_4$ $Fe(OH)_2 + 6NaCl \longrightarrow Na_4[Fe(CN)_6] + 2NaOH$ $3Na_4[Fe(CN)_6] + 4\,FeCl_3 \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3} + 12NaCl$
Sulphur	$2Na + S \xrightarrow{\Delta} \underset{(L.E.)}{Na_2S}$	• L.E. + sodium nitroprusside $\longrightarrow$ deep violet colour • L.E. + CH_3COOH + $(CH_3COO)_2Pb$ $\longrightarrow$ black ppt	$Na_2S + \underset{\text{Sodium nitroprusside}}{Na_2[Fe(CN)_5NO]} \longrightarrow \underset{\text{Deep violet}}{Na_4[Fe(CN)_5NOS]}$ $Na_2S + (CH_3COO)_2Pb \xrightarrow{CH_3COOH} \underset{\text{Black ppt}}{PbS\downarrow} + 2CH_3COONa$
Halogens	$Na + X \xrightarrow{\Delta} \underset{(I.E.)}{NaX}$	L.E. + HNO_3 + $AgNO_3$, if • white ppt. soluble inaq. NH_3 (or NH_4OH) confirms Cl • dull yellow ppt. partially soluble in aq. NH_3 (or NH_4OH) confirms Br. • yellow ppt. insoluble in aq. NH_3 (or NH_4OH) confirms I.	$NaX + AgNO_3 \xrightarrow{HNO_3} \underset{ppt}{AgX\downarrow}$ $\underset{\text{White ppt}}{AgCl} + 2NH_{3(aq)} \longrightarrow \underset{\text{Soluble}}{[Ag(NH_3)_2]Cl}$ $\underset{\text{Dull yellow ppt}}{AgBr} + 2NH_{3(aq)} \longrightarrow \underset{\text{Partially soluble}}{[Ag(NH_3)_2]Br}$ $\underset{\text{Yellow PPT}}{AgI} + 2NH_{3(aq)} \longrightarrow \underset{\text{Insoluble}}{[Ag(NH_3)_2]I}$

Exercise

Equilibrium

1. The reaction quotient (Q) predicts
   (a) The direction of equilibrium to be attained
   (b) The ratio of activities at equilibrium, i.e., K_C
   (c) The ratio of activities at any time
   (d) All of these
2. $CH_3COOH_2^+$ is present in the solution of acetic acid in
   (a) NH_3 (b) Water (c) Benzene (d) HCl
3. When CO_2 is bubbled in excess of water, the following equilibrium is established.
   $$CO_2 + 2H_2O \rightleftharpoons H_3O^+ + HCO_2^-$$
   $$K_a = 3.8\times10^{-7},\ pH = 6$$
   What would be the value of $[HCO_3^-]/[CO_2]$?
   (a) 6 (b) 0.0038 (c) 0.038 (d) 0.38
4. The values of K_{p_1} and K_{p_2} for the reactions
   $X \rightleftharpoons Y + Z$; $A \rightleftharpoons 2B$ are in the ratio 9:1. The total pressure at equilibrium are in the ratio, when the degree of dissociation of X and A are equal is
   (a) 36:1 (b) 1: 1 (c) 3:1 (d) 1:9
5. The pH of blood is 7.4. Assuming that the buffer in blood is carbon dioxide, hydrogen carbonate ion, what is the ratio of conjugate base to acid necessary to maintain blood at its proper

(10) Quantitative Analysis [Estimation of elements]

Estimation of C & H

(Liebig's combustion method)

$$\% \ of \ C = \frac{12}{44} \times \frac{Mass \ of \ CO_2}{Mass \ of \ organic \ compound} \times 100$$

$$\% \ of \ H = \frac{2}{18} \times \frac{Mass \ of \ H_2O}{Mass \ of \ organic \ compound} \times 100$$

Estimation of Halogens (Carius Method)

$$X + AgNO_3 \longrightarrow AgX\downarrow$$

$$\% \ of \ Cl = \frac{35.5}{143.5} \times \frac{W_{AgCl}}{W_{Organic \ compound}} \times 100$$

$$\% \ of \ Br = \frac{80}{188} \times \frac{W_{AgBr}}{W_{Organic \ compound}} \times 100$$

$$\% \ of \ I = \frac{127}{235} \times \frac{W_{AgI}}{W_{Organic \ compound}} \times 100$$

Estimation of Oxygen

% of O = 100 - (Sum of the % of all the elements in the compound) or

$$\% \ of \ O = \frac{16}{44} \times \frac{Mass \ of \ CO_2}{Mass \ of \ organic \ compound} \times 100$$

Estimation of Nitrogen

Duma's Method:

$$C_xH_yN_z + (2x+y/2)CuO \longrightarrow xCO_2 + y/2H_2O + z/2 + N_2 + (2x+y/2) \ Cu$$

$$\% \ of \ N = \frac{28}{22400} \times \frac{V_{N_2} \ mL \ at \ STP}{Wg} \times 100$$

Kjeldhal's Method:

$$N \xrightarrow{Conc. \ H_2SO_4} (NH_4)_2SO_4$$

$$(NH_4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2NH_3 + 2H_2O$$

$$2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

$$\% \ of \ N = \frac{1.4 \times (NV)_{Acid \ used \ for \ NH_3}}{W}$$

Estimation of Sulphur (Carius Method)

$$S + HNO_3 \longrightarrow H_2SO_4$$

$$H_2SO_4 + BaCl_2 \longrightarrow BaSO_4\downarrow + 2HCl$$

$$\% \ of \ S = \frac{32}{233} \times \frac{Mass \ of \ BaSO_4}{Mass \ of \ compound} \times 100$$

Estimation of Phosphorous

$$\% \ of \ P = \frac{31}{1877} \times \frac{Mass \ of \ (NH_4)_3PO_4.12MoO_3}{Mass \ of \ organic \ compound} \times 100$$

$$\% \ of \ P = \frac{62}{222} \times \frac{Mass \ of \ Mg_2P_2O_7}{Mass \ of \ organic \ compound} \times 100$$

pH? ($Ka = 4.5 \times 10^{-7}$)

(a) 9 (b) 10 (c) 11 (d) 12

Redox Reactions

6. The reducing agent among the following is

(a) HNO_3 (b) SO_3 (c) H_2S (d) HNO_2

7. Which of the following is not intramolecular redox reaction?

(a) $(NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + 4H_2O$

(b) $2KClO_3 \longrightarrow 2KCl + 3O_2$

(c) $2Mn_2O_7 \longrightarrow 4MnO_2 + 3O_2$

(d) $2ClO_2 + 5H_2O_2 \xrightarrow{2OH^-} 2Cl^- + 5O_2 + 6H_2O$

8. The position of some metals in the electrochemical series in decreasing electropositive character is given as Mg > Al > Zn > Cu > Ag. What will happen if a copper spoon is used to stir a solution of aluminium nitrate?

(a) The solution becomes blue

(b) There is no reaction

(c) The spoon will get coated with aluminium

(d) An alloy of aluminium and copper is formed

9. The oxides which can not act as reductant?

(I) CO_2 (II) SO_3 (III) P_4O_{10} (IV) NO_2

(a) (I), (II), (III) (b) (II), (III), (IV)

(c) (I), (II), (IV) (d) (III), (IV)

10. What is the equivalent weight of $C_{12}H_{22}O_{11}$ in the following reaction ?

$$C_{12}H_{22}O_{11} + 36HNO_3 \rightarrow 6H_2C_2O_4 + 36NO_2 + 23H_2O$$

(a) $\frac{342}{36}$ (b) $\frac{342}{12}$ (c) $\frac{342}{22}$ (d) $\frac{342}{3}$

Hydrogen

11. The number of hydrogen-bonded water molecule(s) are associated in $CuSO_4.5H_2O$ is
(a) 1 (b) 2 (c) 3 (d) 4

12. Which of the following is not true ?
(a) Hardness of water is shown by its behaviour towards soap
(b) The temporary hardness is due to the presence of Ca and Mg bicarbonates
(c) Permanent hardness is due to the presence of soluble Ca and Mg sulphates and chloride
(d) Permanent hardness can be removed by boiling the water

13. The percentage of H_2O_2 in 1.5 N solution is
(a) 3.6 (b) 2.99 (c) 2.55 (d) 2.4

14. Correct order of occlusion property is
(a) Pd > Pt > Au > Colloidal Pd > Pt
(b) Colloidal Pd > Pd > Pt > Au > Ni
(c) Ni < Au > Pt > Pd > Colloidal Pd
(d) Au > Pt > Pd > Ni > Colloidal Pd

15. 100 mL of tap water containing $Ca(HCO_3)_2$ was titrated with N/50 HCl with methyl orange as indicator. If 30 mL of HCl were required, the temporary hardness as parts of $CaCO_3$ per 10^6 parts of water is
(a) 150 ppm (b) 300 ppm
(c) 450 ppm (d) 600 ppm

S-Block Elements (Alkali & Alkaline Earth Metals)

16. Which of the alkaline earth metal sulphate is least soluble ?
(a) $BeSO_4$ (b) $CaSO_4$
(c) $SrSO_4$ (d) $BaSO_4$

17. Which of the following is used as a source of oxygen in space capsules, submarines and breathing masks?
(a) Li_2O (b) Na_2O_2 (c) KO_2 (d) K_2O_2

18. A sodium salt of an unknown anion when treated with $MgCl_2$ gives white precipitate only on boiling. The anion is
(a) SO_4^{2-} (b) HCO_3^- (c) CO_3^{2-} (d) NO_3^-

19. BeF_2 is soluble in water, whereas, the fluorides of other alkaline earth metals are insoluble because of
(a) Ionic nature of BeF_2
(b) Greater hydration energy of Be^{2+} ion
(c) Covalent nature of BeF_2
(d) None of the above

20. Mixture of $MgCl_2$ and MgO is called
(a) Portland cement (b) Sorel's cement
(c) Double salt (d) None

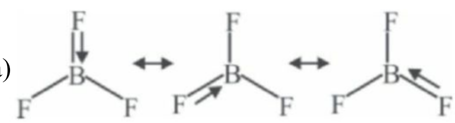
p-Block Elements

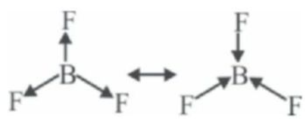
21. $AlCl_3$ is an electron deficient compund but AlF_3 is not. This is because
(a) Atomic size of F is smaller than Cl which makes AlF_3 more covalent
(b) $AlCl_3$ is a covalent compound while AlF_3 is an ionic compound
(c) $AlCl_3$ exists as a dimer but AlF_3 does not
(d) Al in $AlCl_3$ is in sp^3 hybrid state but Al in AlF_3 is in sp^2 state

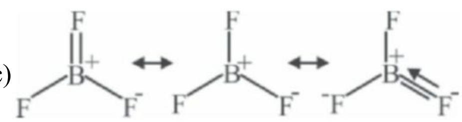
22. Which of the following halides is the most stable?
(a) CF_4 (b) CI_4 (c) CBr_4 (d) CCl_4

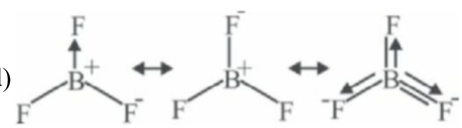
23. Different layers in graphite are held together by:
(a) Ionic bonding (b) Metallic bonding
(c) Covalent bonding (d) Vanderwaals forces

24. Which of the following structures correctly represents the boron trifluoride molecule?

(a)


(b)


(c)


(d)


25. When $SnCl_2$ reacts with $HgCl_2$, the product formed are :
(a) $Sn + HgCl_4$ (b) $SnCl_2 + Hg_2Cl_2$

(c) $SnCl_4$ *and* Hg_2 (d) None of these

Organic Chemistry (Some Basic Principles & Techniques)

26. Homolytic fission of C-C bond in ethane gives an intermediate in which carbon is
(a) sp^3-hybridised (b) sp^2-hybridised
(c) sp-hybridised (d) sp^2d-hybridised

27. In triplet carbenes, the two electrons
(a) are paired in one orbital
(b) are present in different orbitals
(c) have the same spin
(d) Both (b) and (c)

28. Liquid which decompose below their normal boiling points can be distilled at lower temperature by
(a) Increasing the pressure
(b) Decreasing the pressure
(c) Heating in water bath
(d) Heating in sand bath

29. Metamers of ethylpropionate are
(a) C_4H_9COOH *and* $HCOOC_4H_9$
(b) C_4H_9COOH *and* $CH_3OOC_3H_7$
(c) CH_3COOCH_3 *and* $CH_3OOC_3H_7$
(d) $CH_3COOC_3H_7$ *and* $C_3H_7COOCH_3$

30. In column chromatography the MOVING PHASE is constituted by
(a) A substance which have to be separated
(b) Eluent
(c) Adsorbent
(d) Mixture of eluent and substances to be separated

ANSWER KEY

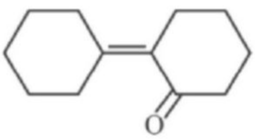
1. d	2. d	3. d	4. a	5. c
6. c	7. d	8. b	9. a	10. a
11. a	12. d	13. c	14. b	15. b
16. d	17. c	18. b	19. b	20. b
21. b	22. a	23. d	24. a	25. c
26. b	27. d	28. b	29. d	30. d

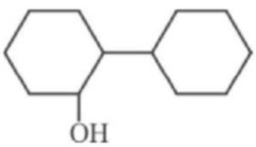
Previous years NEET/AIPMT Questions

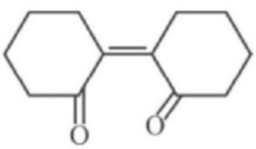
ALDEHYDES, KETONES & CARBOXYLIC ACIDS, CHEMICAL KINETICS

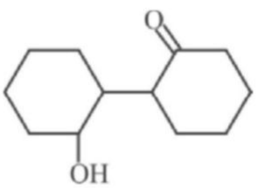
Aldehydes, Ketones & Carboxylic Acids

1. Of the following which is the product formed when cyclohexanone undergoes aldol condensation followed by heating? [2017]

(a) 

(b) 

(c) 

(d) 

2. The product formed by the reaction of an aldehyde with a primary amine is: [2016]

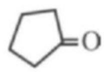
(a) Ketone (b) Carboxylic acid
(c) Aromatic acid (d) Schiff base

3. Reaction of carbonyl compound with one of the following reagents involves nucleophilic addition followed by elimination of water. The reagent is: [2015]

(a) a Grignard reagent
(b) hydrazine in presence of feebly acidic solution
(c) hydrocyanic acid
(d) sodium hydrogen sulphite

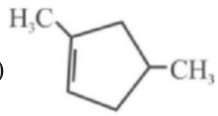
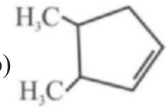
4. An organic compound 'X' having molecular formula $C_5H_{10}O$ yield phenylhydrazone and gives negative response to the iodoform test and Tollens'test. It produces n-pentane on reduction. 'X' could be [2015]

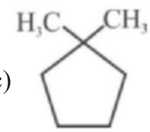
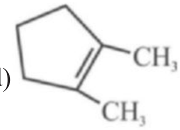
(a) pentanal (b) 2-pentanone
(c) 3-pentanone (d) n-amyl alcohol

5. Treatment of cyclopentanone  with methyllithium gives which of the following species? [2015]

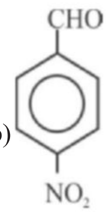
(a) Cyclopentanonyl anion
(b) Cyclopentanonyl cation
(c) Cyclopentanonyl radical
(d) Cyclopentanonyl biradical

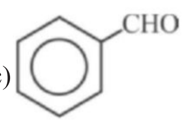
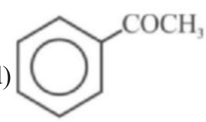
6. A single compound of the structure, [2015] $CH_3COCH_2CH(CH_3)CH_2CH_3$ is obtainable from ozonolysis of which of the following cyclic compounds?

(a)  (b) 

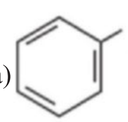
(c)  (d) 

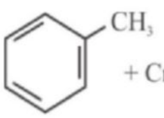
7. Which one is most reactive towards nucleophilic addition reaction? **[2014]**

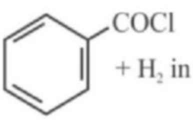
(a)  (b) 

(c)  (d) 

8. Reaction by which Benzaldehyde cannot be prepared? **[2013]**

(a)  + Zn/Hg and conc. HCl

(b)  + CrO_2Cl_2 in CS_2 followed by H_3O^+

(c)  + H_2 in presence of Pd - $BaSO_4$

(d)  + CO + HCl in presence of anhydrous $AlCl_3$

9. Consider the following reaction:

The product 'A' is **[2012]**

(a) $C_6H_5COCH_3$ (b) C_6H_5CHO

(c) C_6H_5Cl (d) C_6H_5OH

10. The correct order of decreasing acid strength of trichloroacetic acid (A), trifluoroacetic acid (B), acetic acid (C) and formic acid (D) is **[2012]**

(a) A > C > B > D (b) B > D > C > A

(c) A > B > C > D (d) B > A > D > C

11. Which of the following compounds will give a yellow precipitate with iodine and alkali? **[2012]**

(a) Acetophenone (b) Methyl acetate

(c) Acetamide (d) 2- Hydroxypropane

12. Consider the reaction:

$RCHO + NH_2NH_2 \rightarrow R-CH=N\ NH_2$

What sort of reaction is it? **[2012]**

(a) Electrophilic substitution - elimination reaction

(b) Nucleophilic addition - elimination reaction

(c) Electrophilic addition - elimination reaction

(d) Free radical addition - elimination reaction

13. Acetone is treated with excess of ethanol in the presence of hydrochloric acid. The product obtained is **[2012]**

(a) $CH_3CH_2CH_2-\overset{O}{\overset{\|}{C}}-CH_3$

(b) $CH_3CH_2CH_2-\overset{O}{\overset{\|}{C}}-CH_2CH_2CH_3$

(c) $(CH_3)_2C<\begin{matrix}OH\\OC_2H_5\end{matrix}$

(d) $(CH_3)_2C<\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}$

14. CH_3CHO and $C_6H_5CH_2CHO$ can be distinguished chemically by **[2012]**

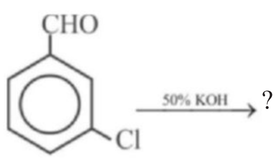
(a) Benedict's test

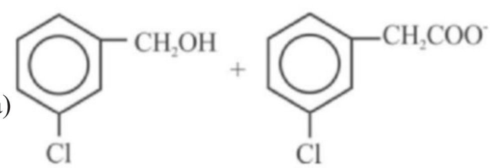
(b) Iodoform test

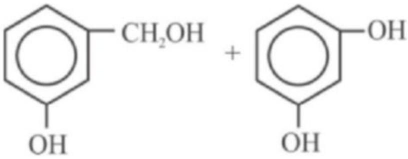
(c) Tollen's reagent test

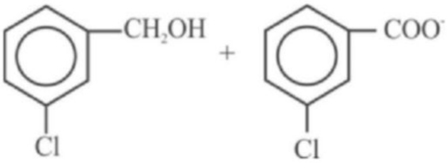
(d) Fehling's solution test

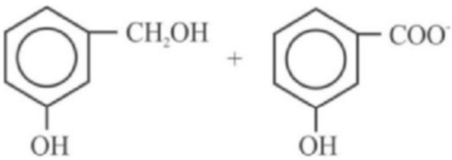
15. Predict the products in the given reaction. **[2012]**



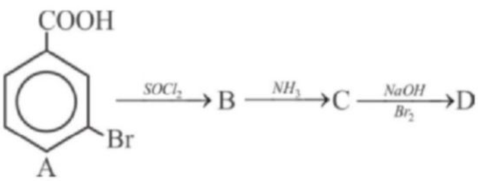
(a) 

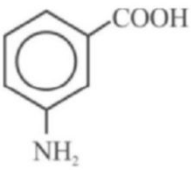
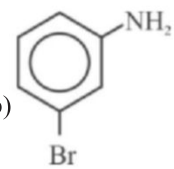
(b) 

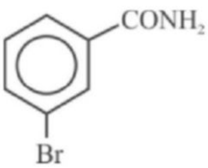
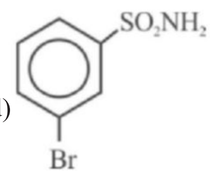
(c) 

(d) 

16. In a set of reaction m-bromobenzoic acid gave a product D. Identify the product D **[2011]**



(a) 
(b) 

(c) 
(d) 

17. Clemmensen reduction of a ketone is carried out in the presence of which of the following? **[2011]**

(a) Zn-Hg with HCl (b) $LiAlH_4$

(c) H_2 and Pt as catalyst (d) Glycol with KOH

18. Acetamide is treated with the following reagents separately. Which one of these would yield methyl amine? **[2010]**

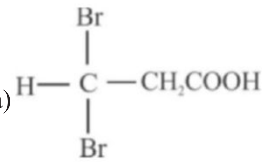
(a) Hot. conc. H_2SO_4 (b) $NaOH + Br_2$

(c) PCl_5 (d) Sodalime

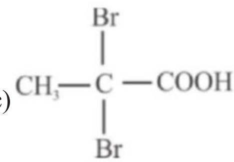
19. The relative reactivities of acyl compounds towards nucleophilic substitution are in the order of: **[2010]**

(a) acyl chloride > ester > acid anhydride > amide
(b) acyl chloride > acid anhydride > ester > amide
(c) ester > acyl chloride > amide > acid anhydride
(d) acid anhydride > amide > ester > acyl chloride

20. Propionic acid with $Br_2|P$ yields a dibromo product. Its structure would be **[2009]**

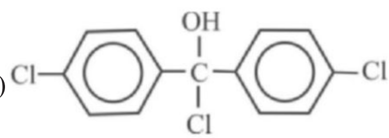
(a) 

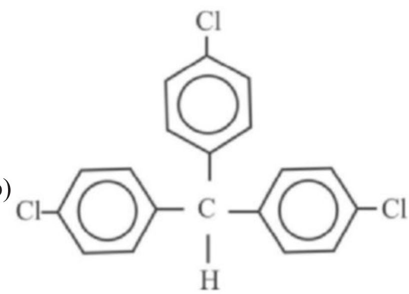
(b) CH_2Br-CH_2-COBr

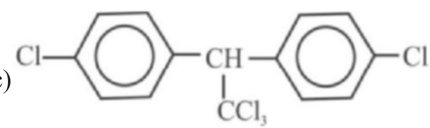
(c) 

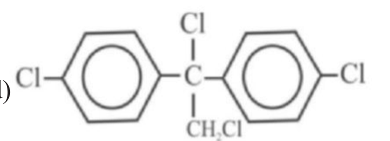
(d) $CH_2Br-CHBr-COOH$

21. Trichloroacetaldehyde, CCl_3CHO reacts with chlorobenzene in presence of sulphuric acid and produces **[2009]**

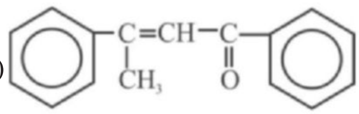
(a) 

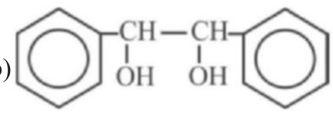
(b) 

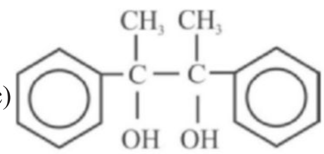
(c) 

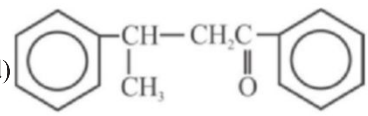
(d) 

22. Acetophenone when reacted with a base C_2H_5ONa, yields a stable compound which has the structure: **[2008]**

(a) 

(b) 

(c) 

(d) 

23. The correct decreasing order of their reactivity towards hydrolysis is **[2007]**

(i) C_6H_5COCl

(ii) 

(iii) 

(iv) 

(a) (iv) > (ii) > (i) > (iii) (b) (ii) > (iv) > (iii) > (i)
(c) (i) > (ii) > (iii) > (iv) (d) (ii) > (iv) > (i) > (iii)

24. Which of the following orders is wrong with respect to property indicated? **[2007]**
(a) Benzoic acid > Phenol > Cyclohexanol (Acid strength)
(b) Aniline > Cyclohexylamine > Benzamide (Base strength)
(c) Formic acid > Acetic acid > Propionic acid (Acid strength)
(d) Fluoro acetic acid > Chloro acetic acid > Bromo acetic acid (Acid strength)

25. The product formed in aldol condensation is **[2007]**

(a) an α,β -unsaturated ester
(b) a β -hydroxy aldehyde or a β -hydroxy ketone
(c) an β -hydroxy acid
(d) an α -hydroxy aldehyde or ketone

26. Which of the following on treatment with 50% aqueous NaOH gives alcohols and acid? **[2007]**
(a) CH_3COCH_3 (b) $C_6H_5CH_2CHO$
(c) C_6H_5CHO (d) $CH_3CH_2CH_2CHO$

27. Reduction of aldehydes and ketones into hydrocarbons using Zn - Hg + HCl conc. is called **[2007]**
(a) Wolff-Kishner reduction
(b) Clemmensen reduction
(c) Cope reaction
(d) Dow reaction

Chemical Kinetics

1. Mechanism of a hypothetical reaction
$X_2 + Y_2 \rightarrow 2XY$ is given below : **[2017]**
(i) $X_2 \rightleftharpoons X + X$ (fast)
(ii) $X + Y_2 \rightarrow XY + Y$ (slow)
(iii) $X + Y \rightarrow XY$ (fast)
The overall order of the reaction will be :
(a) 2 (b) 0 (c) 1.5 (d) 1

2. A first order reaction has a specific reaction rate of $10^{-2}\ sec^{-1}$. How much time it takes for 20 g of the reactant to reduce to 5g? **[2017]**
(a) 138.6 sec (b) 346.5 sec
(c) 693.0 sec (d) 238.6 sec

3. The rate of a first-order reaction is 0.04 $molL^{-1}S^{-1}$ at 10 seconds and 0.03 $molL^{-1}S^{-1}$ at 20 seconds after initiation of the reaction. The half-life period of the reaction is: **[2016]**
(a) 34.1 s (b) 44.1 s (c) 54.1 s (d) 24.1 s

4. The addition of a catalyst during a chemical reaction alters which of the following quantities? **[2016]**
(a) Internal energy (b) Enthalpy
(c) Activation energy (d) Entropy

5. The rate constant of the reaction $A \rightarrow B$ is 0.6×10^{-3} mole per second. If the concentration of A is 5 M, then concentration of B after 20 minutes is: **[2015]**
(a) 0.36 M (b) 1.08 M
(c) 0.72 M (d) 3.60 M

6. When initial concentration of a reactant is doubled in a reaction, its half-life period is not affected. The

order of the reaction is **[2015]**

(a) Zero

(b) First

(c) Second

(d) More than zero but less than first

7. The activation energy of a reaction can be determined from the slope of which of the following graphs? **[2015]**

(a) $\ln k$ vs. T (b) $\frac{\ln k}{T}$ vs. T

(c) $\ln k$ vs. $\frac{1}{T}$ (d) $\frac{T}{\ln k}$ vs. $\frac{1}{T}$

8. A reaction having equal energies of activation for forward and reverse reaction has **[2013]**

(a) $\Delta H = \Delta G = \Delta S = 0$ (b) $\Delta S = 0$

(c) $\Delta G = 0$ (d) $\Delta H = 0$

9. What is the activation energy for a reaction if its rate doubles when the temperature is raised from $20^0 C$ to $35^0 C$? $(R = 8.314 J\ mol^{-1} K^{-1})$ **[2013]**

(a) $15.1 kJ\ mol^{-1}$ (b) $342 kJ\ mol^{-1}$

(c) $269 kJ\ mol^{-1}$ (d) $34.7 kJ\ mol^{-1}$

10. Activation energy (E_a) and rate constants $(k_1\ and\ k_2)$ of a chemical reaction at two different temperatures $(T_1\ and\ T_2)$ are related by **[2012]**

(a) $\ln\frac{k_2}{k_1} = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

(b) $\ln\frac{k_2}{k_1} = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

(c) $\ln\frac{k_2}{k_1} = -\frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

(d) $\ln\frac{k_2}{k_1} = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

11. In a reaction, $A + B \rightarrow$ Product, rate is doubled when the concentration of B is doubled, and rate increases by a factor of 8 when the concentrations of both the reactants (A and B) are doubled, rate law for the reaction can be written as **[2012]**

(a) $Rate = k[A][B]^2$ (b) $Rate = k[A]^2[B]^2$

(c) $Rate = k[A]^2[B]$ (d) $Rate = k[A][B]$

12. In a zero-order reaction for every $10^0 C$ rise of temperature, the rate is doubled. If the temperature is increased from $10^0 C$ to $100^0 C$, the rate of the reaction will become **[2012]**

(a) 265 times (b) 128 times

(c) 64 times (d) 512 times

13. The rate of the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$ can be written in three ways: **[2011]**

$$\frac{-d[N_2O_5]}{dt} = k[N_2O_5]$$

$$\frac{d[NO_2]}{dt} = k'[N_2O_5]$$

$$\frac{d[O_2]}{dt} = k''[N_2O_5]$$

The relationship between k and k' and k'' are:

(a) $k' = 2k; k'' = 2k$ (b) $k' = k; k'' = k$

(c) $k' = 2k; k'' = k$ (d) $k' = 2k; k'' = k/2$

14. Which one of the following statements for the order of a reaction is incorrect? **[2011]**

(a) Order is not influenced by stoichiometric coefficient of the reactants.

(b) Order of reaction is sum of power to the concentration terms of reactants to express the rate of reaction.

(c) Order of reaction is always whole number.

(d) Order can be determined only experimentally.

15. During the kinetic study of the reaction $2A + B \rightarrow C + D$ following results were obtained.

Run	$[A]$ in M	$[B]$ in M	Initial rate of formation of D in ms^{-1}
I	0.1	0.1	6.0×10^{-3}
II	0.3	0.2	7.2×10^{-2}
III	0.3	0.4	2.88×10^{-1}
IV	0.4	0.1	2.40×10^{-2}

On the basis of above data which one is correct? **[2010]**

(a) $r = k[A]^2[B]^2$ (b) $r = k[A][B]^2$

(c) $r = k[A]^2[B]$ (d) $r = k[A][B]$

16. For the reaction $N_2O_5 \rightarrow 2NO_2 + \frac{1}{2}O_2$, the rate of disappearance of N_2O_5 is $6.25\times10^{-3} mol L^{-1} s^{-1}$.

The rate of formation of NO_2 and O_2 will be respectively. **[2010]**

(a) $6.25\times10^{-3}\,molL^{-1}s^{-1}$ and $3.125\times10^{-3}\,molL^{-1}s^{-1}$

(b) $1.25\times10^{-3}\,molL^{-1}s^{-1}$ and $3.125\times10^{-3}\,molL^{-1}s^{-1}$

(c) $6.25\times10^{-3}\,molL^{-1}s^{-1}$ and $6.25\times10^{-3}\,molL^{-1}s^{-1}$

(d) $1.25\times10^{-2}\,molL^{-1}s^{-1}$ and $3.125\times10^{-3}\,molL^{-1}s^{-1}$

17. The rate of reaction:

$2NO + Cl_2 \rightarrow 2NOCl$ is given by the rate, equation rate $= k[NO]^2[Cl_2]$. The value of the rate constant can be increased by **[2010]**

(a) Increasing the concentration of the Cl_2
(b) Increasing the concentration of NO
(c) Increasing the temperature
(d) Doing all of these

18. For an endothermic reaction energy of activation is E_a and enthalpy of reaction is ΔH (both in $kJ\ mol^{-1}$). Minimum value of E_a will be **[2010]**

(a) $> \Delta H$ (b) $= 0$ (c) $< \Delta H$ (d) $= \Delta H$

19. Half-life period of a first-order reaction is 1386 seconds. The specific rate constant of the reaction is **[2009]**

(a) $0.5\times10^{-2}\,s^{-1}$ (b) $0.5\times10^{-3}\,s^{-1}$

(c) $5.0\times10^{-2}\,s^{-1}$ (d) $5.0\times10^{-3}\,s^{-1}$

20. For the reaction, $N_2 + 3H_2 \rightarrow 2NH_3$,

if $\dfrac{d[NH_3]}{dt} = 2\times10^{-4}\,mol\ L^{-1}s^{-1}$, the value of $\dfrac{-d[H_2]}{dt}$ would be: **[2009]**

(a) $4\times10^{-4}\,mol\ L^{-1}s^{-1}$ (b) $6\times10^{-4}\,mol\ L^{-1}s^{-1}$

(c) $1\times10^{-4}\,mol\ L^{-1}s^{-1}$ (d) $3\times10^{-4}\,mol\ L^{-1}s^{-1}$

21. For the reaction $A + B \rightarrow$ products, it is observed that: **[2009]**

(1) On doubling the initial concentration of A only, the rate of reaction is also doubled and
(2) On doubling the initial concentrations of both A and B, there is a change by a factor of 8 in the rate of the reaction.
The rate law of this reaction is given by

(a) $rate = [A][B]^2$ (b) $rate = k[A]^2[B]^2$

(c) $rate = k[A][B]$ (d) $rate = k[A]^2[B]$

22. In the reaction

$BrO_3^-(aq) + 5Br^-(aq) + 6H^+ \rightarrow 3Br_2(l) + 3H_2O(l)$

The rate of appearance of bromine (Br_2) is related to rate of disappearance of bromide ions as following: **[2009]**

(a) $\dfrac{d[Br_2]}{dt} = \dfrac{3}{5}\dfrac{d[Br^-]}{dt}$ (b) $\dfrac{d[Br_2]}{dt} = -\dfrac{3}{5}\dfrac{d[Br^-]}{dt}$

(c) $\dfrac{d[Br_2]}{dt} = -\dfrac{5}{3}\dfrac{d[Br^-]}{dt}$ (d) $\dfrac{d[Br_2]}{dt} = \dfrac{5}{3}\dfrac{d[Br^-]}{dt}$

23. The bromination of acetone that occurs in acid solution is represented by this equation.

$CH_3COCH_3(aq) + Br_2(aq) \rightarrow$

$CH_3COCH_2Br(aq) + H^+(aq) + Br^-(aq)$

These kinetic data were obt ained for given reaction concentrations.
Initial concentrations, M

$[CH_3COCH_3]$	Br_2	H^+	*Initial rate, disappearance of* Br_2
0.30	0.05	0.05	5.7×10^{-5}
0.30	0.10	0.05	5.7×10^{-5}
0.30	0.10	0.10	1.2×10^{-4}
0.40	0.05	0.20	3.1×10^{-4}

Based on these data, the rate equation is **[2008]**

(a) $rate = k[CH_3COCH_3][Br_2][H^+]$

(b) $rate = k[CH_3COCH_3][H^+]$

(c) $rate = k[CH_3COCH_3][Br_2][H^+]^2$

(d) $rate = k[CH_3COCH_3][Br_2]$

24. The rate constants k_1 and k_2 for two different reactions are $10^{16}e^{-2000/T}$ and $10^{15}e^{-1000/T}$ respectively. The temperature at which $k_1 = k_2$ is **[2008]**

(a) $\dfrac{1000}{2.303}K$ (b) 1000 K

(c) $\dfrac{2000}{2.303}K$ (d) 2000 K

25. If 60% of a first-order reaction was completed in 60 min, 50% of the same reaction would be completed in approximately **[2007]**

(a) 40 min (b) 50 min

(c) 45 min (d) 60 min

26. In a first-order reaction $A \rightarrow B$, if K is the rate constant and initial concentration of the reactant is 0.5 M, then half-life is **[2007]**

(a) $\frac{\log_{10} 2}{k}$ (b) $\frac{0.693}{0.5k}$

(c) $\frac{\ln 2}{k}$ (d) $\frac{\ln 2}{k\sqrt{0.5}}$

ANSWER KEY

Aldehydes, Ketones & Carboxylic Acids

1. a	2. d	3. b	4. c	5. a
6. a	7. b	8. a	9. b	10. d
11. a, d	12. b	13. d	14. b	15. c
16. b	17. a	18. b	19. b	20. c
21. c	22. a	23. d	24. b	25. b
26. c	27. b			

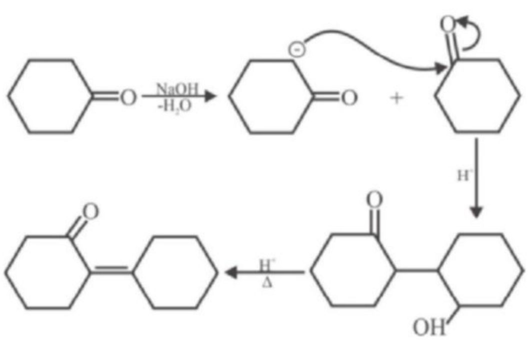
Chemical Kinetics

1. c	2. a	3. d	4. c	5. c
6. b	7. c	8. d	9. d	10. b,d
11. c	12. d	13. d	14. c	15. b
16. d	17. c	18. d	19. b	20. d
21. a	22. b	23. b	24. a	25. c
26. c				

HINTS & SOLUTIONS

Aldehydes, Ketones & Carboxylic Acids

1.Sol:



2.Sol: $\overset{R}{\underset{H}{>}}C=O + H_2N\text{-}R' \xrightarrow{H^+} \overset{R}{\underset{H}{>}}C=\ddot{N}\text{-}R'$

Aldehyde Primary amine Schiffs Base

3.Sol: Reaction of carbonyl compounds with ammonia derivatives is an example of Nucleophilic addition elimination reaction.

4.Sol: Compound 'X' yields phenyl hydrazone $\Rightarrow -\overset{O}{\overset{\|}{C}}-$ group

Negative iodoform test

$\Rightarrow CH_3-\overset{O}{\overset{\|}{C}}-$ group is absent

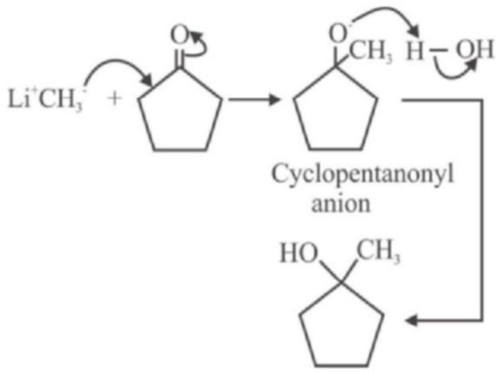
Negative Tollen's test $\Rightarrow$ ketone

hence, the compound is 3-pentanone.

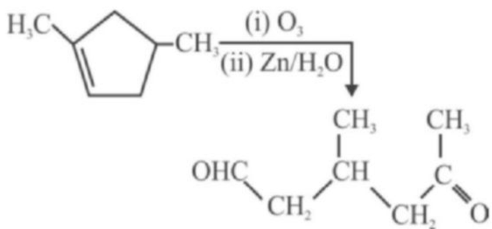
$$CH_3CH_2-\overset{O}{\overset{\|}{C}}-CH_2CH_3 \xrightarrow{\text{Reduction}} CH_3CH_2CH_2CH_2CH_3$$

3-Pentanone ($C_5H_{10}O$) *n*-Pentane

5.Sol:



6..Sol:

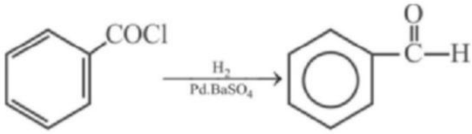


7.Sol: Any substituent in the carbonyl compound that increases the positive charge on the carbonyl carbon will increase reactivity towards nucleophilic addition.

$-NO_2$ shows -M effect hence

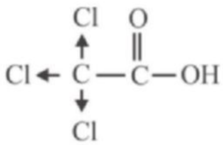
8.Sol: Zn/Hg and HCl reduce carbonyl group to methylene group (Clemmensen reduction).

9.Sol:

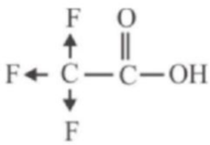


It is Rosenmund's reaction (reduction)

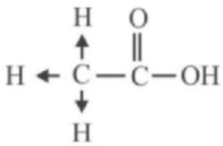
10.Sol:



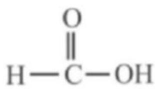
(A)



(B)

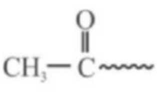
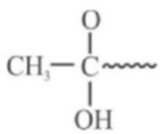


(C)

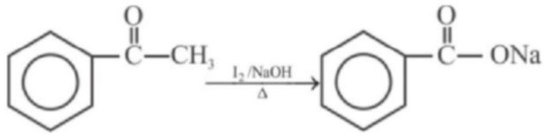


(D)

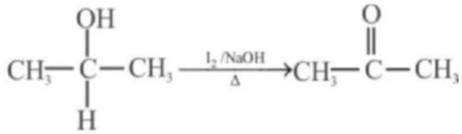
The presence of electron withdrawing group. in carboxylic acid increases acidic character. Also electron withdrawing nature of F is more than Cl.

11.Sol:  and  give iodoform test

It is iodoform reaction. Acetophenone and 2-Hydroxy propane both give a yellow precipitate of CHI_3 (Iodoform) with iodine and alkali.



Acetophenone



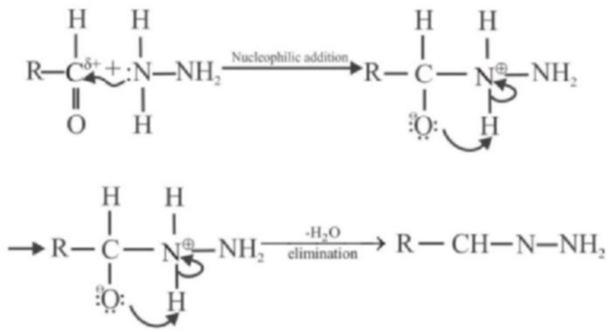
2-Hydroxy propane

$\xrightarrow[\Delta]{I_2/NaOH} CH_3COONa + CHI_3$

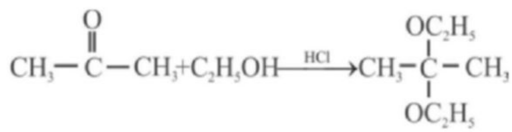
12.Sol: Consider the reaction:

$RCHO + NH_2NH_2 \rightarrow RCH = N\text{-}NH_2$

The reaction is nucleophilic addition elimination reaction.

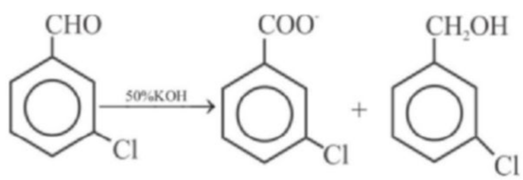


13.Sol:

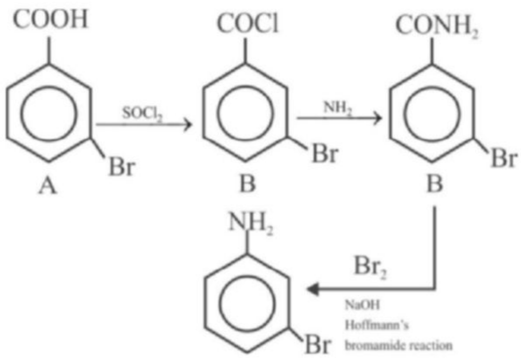


14. Sol: CH_3CHO will give positive iodoform test as it has CH_3CO-

15.Sol: It is Cannizzaro's reaction.



16.Sol:



17.Sol: Clemmensen reduction involves Zn-Hg with HCl to convert $>C=O$ group to $>CH_2$.

18.Sol: This is Hoffmann's bromamide reaction with stepping down of series.

19.Sol: Better is leaving group higher will be reactivity of acyl compound towards nucleophilic acyl substitution. Weaker is its acid and vice-versa.

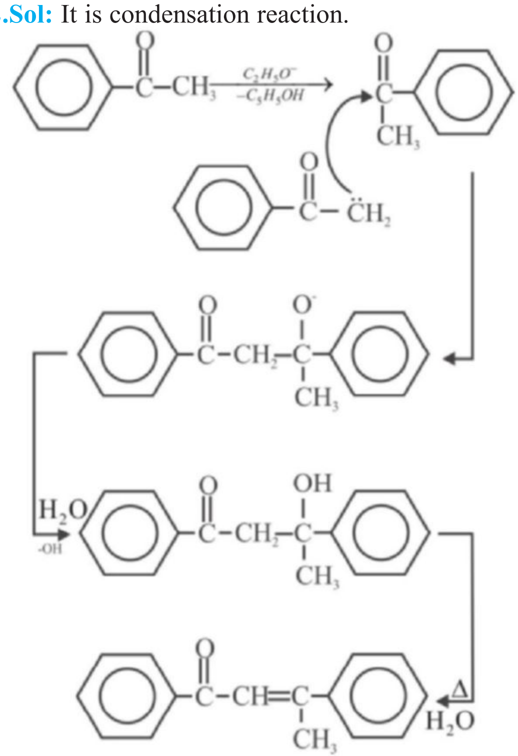
20.Sol: $CH_3CH_2COOH \rightarrow CH_3CHBr.COOH$

$$\xrightarrow{Br_2/P} CH_3-\underset{Br}{\overset{Br}{C}}-COOH$$

This is Hell-Volhard-Zelinsky reaction.

21.Sol: It is preparation of DDT.

22.Sol: It is condensation reaction.



23.Sol: The ease of hydrolysis depends upon the magnitude of the +ve charge on the carbonyl group.

24.Sol: Cyclohexylamines are more basic than aniline; the later shows resonance.

25.Sol: $CH_3CH_2CHO + CH_3CHO \rightarrow$

$$CH_3-CH_2-\overset{OH}{CH}-CH_2CHO$$

or

$$CH_3-CO-CH_3 + \begin{matrix}CH_3\\CH_3\end{matrix}\!\!>CO \rightarrow \begin{matrix}CH_3\\CH_3\end{matrix}\!\!>C-\overset{OH}{CH}-COCH_3$$

26.Sol: It is Cannizzaro's reaction shown by aldehydes lacking with α -H atom.

27. Sol: It is called Clemmensen reduction.

Chemical Kinetics

1.Sol: According to law of mass action

$$r = k[X][Y_2] \quad ....(i)$$

from fast step - 1

$$K_{eq} = \frac{[X]^2}{[X_2]}$$

$$[X]^2 = K_{eq}.[X_2]$$

$$[X] = \sqrt{K_{eq}}[X_2]^{1/2} \quad ...(ii)$$

From equation (i) & (ii)

$$r = k.\sqrt{K_{eq}}[X_2]^{1/2}[Y_2]$$

$$r = k'[X_2]^{1/2}[Y_2].$$

Overall order of reaction $=1+0.5=1.5$

2.Sol: Half life of first order reaction $t_{1/2} = \dfrac{0.693}{k}$

$$= \frac{0.693}{10^{-2}} = 69.3\,sec$$

Method - 1

$$20g \xrightarrow{t_{1/2}} 10g \xrightarrow{t_{1/2}} 5g$$

Total time $= 2t_{1/2} = 2\times 69.3 = 138.6\,sec$

Method - 2

$$t = \frac{2.303}{k}\log\frac{[A]_o}{[A]_t}$$

$$t = \frac{2.303}{10^{-2}}\log\frac{20}{5} \Rightarrow t = 138.6\,\text{sec}$$

3.Sol:

$$k = \frac{2.303}{(t_2 - t_1)}\log\frac{(a - x_1)}{(a - x_2)}$$

$$= \frac{2.303}{(20-10)}\log\left(\frac{0.04}{0.03}\right)$$

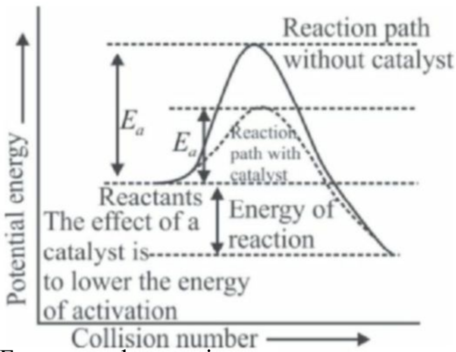
$$= \frac{2.303 \times 0.1249}{10}$$

$$\frac{2.303 \times \log 2}{t_{1/2}} = \frac{2.303 \times 0.1249}{10}$$

$$t_{1/2} = \frac{0.3010 \times 10}{0.1249} = 24.1\,\text{sec}$$

4.Sol: Catalyst can affect only activation energy of the chemical reaction and cannot alter any thermodynamic parameters:

$(i.e. \Delta H, \Delta G, \Delta S)$



5.Sol: For zero order reaction:

$$x = kt = 0.6 \times 10^{-3} \times 20 \times 60$$

$$x = 0.72M$$

6.Sol: Half-life period of a first-order reaction is independant of initial concentration,

$$t_{1/2} = \frac{0.693}{k}$$

7.Sol: Accroding to Arrhenius equation,

$$k = Ae^{-E_a/RT}$$

$$\ln k = \ln A - \frac{E_a}{RT}$$

Hence, if ln k is plotted against 1/T, slope of the line will be $-E_a / RT$

8.Sol: $\Delta H = (E_a)_f - (E_a)_b = 0$

9.Sol:

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\log 2 = \frac{E_a}{2.303 \times 8.314}\left[\frac{1}{293} - \frac{1}{308}\right]$$

$$0.3 = \frac{E_a}{2.303 \times 8.314} \times \frac{15}{293 \times 308}$$

$$E_a = \frac{0.3 \times 2.303 \times 8.314 \times 293 \times 308}{15}$$

$$= 34673\,\text{J mol}^{-1} = 34.7\,\text{J mol}^{-1}$$

10.Sol: On integrating within limits k_1 to k_2 and T_1 to T_2

$$\int_{k_1}^{k_2} \ln k = -\frac{E_a}{R}\int_{T_1}^{T_2}\frac{1}{T}$$

$$\ln\frac{k_2}{k_1} = \frac{E_a}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right] = \frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

or $$\ln\frac{k_2}{k_1} = \frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

Options (b) and (d) both are one and the same and are correct.

11.Sol: Let $r = k[A]^m[B]^n$

$$r_1 = k[A]^m[2B]^n$$

$$r_2 = k[2A]^m[2B]^n$$

Also, $\frac{r_1}{r} = 2$ and $\frac{r_2}{r} = 8$ (Given)

Therefore $m = 2$ and $n = 1$

$$\therefore r = k[A]^2[B]^1$$

12.Sol: Rate or rate constant doubles for every 10^o or 10K rise in temperature

$$\therefore \frac{r_{100}}{r_{10}} = (2)^9 = 512$$

13.Sol: Rate of disappearance of reactants = Rate of appearance of products

$$-\frac{1}{2}\frac{d[N_2O_5]}{dt}=\frac{1}{4}\frac{d[NO_2]}{dt}=\frac{d[O_2]}{dt}$$

$$\frac{k}{2}=\frac{k'}{4}=k" \quad k=2k, k"=\frac{k}{2}$$

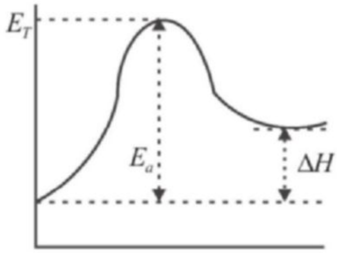
14.Sol: Order of reaction may be fractional.

15.Sol: $r=K[A]^m[B]^n$

16.Sol: $-\frac{d[N_2O_5]}{dt}=\frac{1}{2}\frac{d[N\,O_5]}{dt}=\frac{2d[O_2]}{dt}=R.O.R$

17.Sol: 15k increases with increase in temperature

18.Sol:



19.Sol: For first order:

$$k=\frac{0.693}{t_{1/2}}=\frac{0.693}{13.86}=5\times10^{-4}s^{-1}$$

20.Sol: $$\frac{1}{2}\frac{d[NH_3]}{dt}=\frac{1}{3}\frac{d[H_2]}{dt}$$

$$\therefore -\frac{d[H_2]}{dt}=\frac{3}{2}\times\frac{d[NH_3]}{dt}$$

$$=\frac{3}{2}\times2\times10^{-4}=3\times10^{-4}$$

21.Sol: $r=k[A]^m[B]^n$ ...(i)

$2r=k[2A]^m[B]^n$ ...(ii)

$8r=k[2A]^m[2B]^n$ ...(iii)

By (i) and (ii), m = 1

By (ii) and (iii), n = 2

$$\therefore r=k[A]^1[B]^2$$

22.Sol: $$\frac{1}{3}\frac{d[Br_2]}{dt}=-\frac{1}{5}\frac{d[Br^-]}{dt}=R.O.R$$

23.Sol: $r=k[CH_3COCH_3]^a[Br_2]^b[H^+]^c$

$5.7\times10^{-5}=k[0.30]^a[0.05]^b[0.05]^c$ ...(1)

$5.7\times10^{-5}=k[0.30]^a[0.10]^b[0.05]^c$ ...(2)

$1.2\times10^{-4}=k[0.30]^a[0.10]^b[0.10]^c$ ...(3)

$3.1\times10^{-4}=k[0.40]^a[0.05]^b[0.20]^c$ ...(4)

By (1) and (2) b = 0

By (2) and (3) c = 1

By (3) and (4) a = 1

24.Sol: $k_1=10^{16}e^{-2000/T}; k_2=10^{15}e^{-1000/T}$

if $k_1=k_2$ then $10^{16}e^{-2000/T}=10^{15}e^{-1000/T}$

or $\log 10-\frac{2000}{T}=-\frac{1000}{T}$ or $T=\frac{1000}{2.303}K$

25.Sol: $$60=\frac{2.303}{k}\log\frac{100}{40}$$

$$t_{1/2}=\frac{2.303}{k}\log\frac{100}{50}$$

$$\therefore \frac{60}{t}=\frac{0.40}{0.310}$$

$\therefore$ t = 45 minute

26.Sol: For *Ist* order reaction,

$$k=\frac{2.303\log_{10}2}{t_{1/2}}$$

$$t_{1/2}=\frac{0.693}{k}=\frac{\ln 2}{k}$$

MOCK TEST PAPER

2018 2019

JEE MAIN - 4

CHEMISTRY

1. A, B and C are hydroxy-compounds of the elements X, Y and Z respectively. X, Y and Z are in the same period of the periodic table. A gives an aqueous solution of pH less than seven. B reacts with both strong acids and strong alkalies. C gives an aqueous solution which is strongly alkaline

Which of the following statements is/are true:

I : The three elements are metals

II : The electronegativities decrease from X to Y to Z.

III : The atomic radius decreases in the order X, Y and Z.

IV : X, Y and Z could be phosphorus, aluminium and sodium respectively :

(a) I, II, III only correct

(b) I, III only correct

(c) II, IV only correct

(d) II, III, IV only correct

2. Basic, acidic and amphoteric oxides among them

(a) A, B ,C (b) B, A, C

(c) A, C, B (d) B, C, A

3. Molecular shapes of SCl_4, CCl_4 and XeF_4 are

(a) Same with 2,0 and 1 lone pairs of electrons respectively

(b) Same with 1,1 and 1 lone pairs of electrons respectively

(c) Different with 1,0 and 2 lone pairs of electrons respectively

(d) Different with 1,1 and 1 lone pairs of electrons respectively

4. KF combines with HF to form KHF_2. The compound contains the species

(a) K^+, F^- and H^+ (b) K^+, F^- and HF

(c) K^+ and $[HF_2]^-$ (d) $[KHF]^+$ and F_2

5. 1.75 L of a gas at $127°C$ and 5 atm is converted to 2.875 L at $85°C$ and 1 atm. The percentage of gas escaped is

(a) 11.11% (b) 23.2% (c) 56.3% (d) 63.5%

6. A mixture of dihydrogen and dioxygen at one bar pressure contains 20% by weight of dihydrogen. Calculate the partial pressure of dihydrogen.

(a) 0.2 (b) 0.4 (c) 0.6 (d) 0.8

7. At $25°C$ and 1 atm, N_2O_4 dissociates by the reaction,

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

If it is 35% dissociated at given condition, find the volume of above mixture that will diffuse if 20 mL of pure O_2 diffuses in 10 min at same temperature and pressure.

(a) 13.7 mL (b) 13.7 L (c) 68 mL (d) 68 L

8. For a first order reaction $A \rightarrow B$ the reaction rate at which reactant concentration of 0.01 M is found to be 2.0×10^{-5} M sec^{-1}. The half-life period of the reaction is :

(a) 30 s (b) 300 s (c) 220 s (d) 347s.

9. Which of the following statements regarding the molecularity of reaction is wrong?

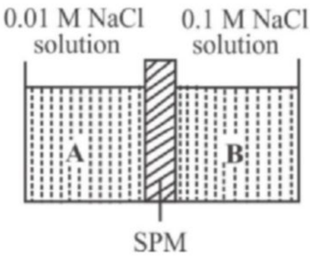
(a) It is the number of molecules of the reactions taking part in a single step chemical reaction.

(b) It is calculated from the reaction mechanism.

(c) It may be either a whole number or fractional.
(d) It depends on the rate determining step in the reaction.

10. The specific heat of a gas at constant volume is 0.075 cal/g-K. Predict the atomicity of the gas. (Molar mass of gas is $40\ g\ mol^{-1}$.)
(a) 1 (b) 2
(c) 3 (d) None of these

11. Two solutions marked as A and B are separated through semipermeable membrane as below. The phenomenon undergoing

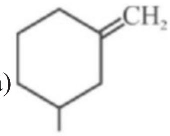


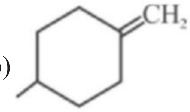
(a) Na^+ moves from solution A to solution B
(b) Both Na^+ and Cl^- moves from solution (A) to solution (B)
(c) Both Na^+ and Cl^- moves from solution (B) to (A)
(d) Solvent molecules moves from solution (A) to (B)

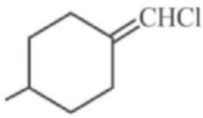
12. A solution is obtained by mixing 300g of 25% solution and 400g of 40% solution by mass.The mass percentage of the resulting solution is:
(a) 66.66% (b) 3.36%
(c) 33.6% (d) 22.4%

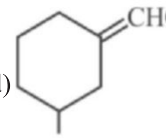
13. Molar conductance of 0.1 M acetic acid is $7\ ohm^{-1}\ cm^2 mol^{-1}$. If the molar conductance of acetic acid at infinite dilution is $380.8\ ohm^{-1} cm^2 mol^{-1}$, the value of dissociation constant will be:
(a) $3.38 \times 10^{-5}\ mol\ dm^{-3}$ (b) $226 \times 10^{-5}\ mol\ dm^{-3}$
(c) $1.66 \times 10^{-3}\ mol\ dm^{-1}$ (d) $1.66 \times 10^{-2}\ mol\ dm^{-3}$

14. Which of the following is crotonic acid?
(a) $CH_2 = CH - COOH$
(b) $C_6H_5 - CH = CH - COOH$
(c) $CH_3 - CH = CH - COOH$
(d) $\begin{array}{l} CH - COOH \\ \| \\ CH - COOH \end{array}$

15. Geometrical isomerism shows
(a) 

(b) 

(c) 

(d) 

16. Which of the following possesses highest melting point ?
(a) Chlorobenzene (b) o-Dichlorobenzene
(c) m-Dichlorobenzene (d) p-Dichlorobenzene

17. The compound "A" when treated with ceric ammonium nitrate solution gives yellow ppt. The compound "A" is
(a) Alcohol (b) Alkane
(c) Aldehyde (d) Acid

18. $C_6H_5COCOC_6H_5 \xrightarrow{OH^-} (C_6H_5)_2C(OH)COOH.$
The above reaction is known as
(a) Beckmann rearrangement
(b) Benzilic acid rearrangement
(c) Benzoin condensation
(d) Aldol condensation

19. The pair of amphoteric hydroxides is
(a) $Al(OH)_3, LiOH$ (b) $Be(OH)_2, Mg(OH)_2$
(c) $B(OH)_3, Be(OH)_2$ (d) $Be(OH)_2, Zn(OH)_2$

20. Lithopone is a mixture of:
(a) Barium sulphate and zinc sulphide
(b) Barium sulphide and zinc sulphide
(c) Calcium sulphate and zinc sulphide
(d) Calcium sulphide and zinc sulphide

21. Acidified potassium dichromate oxidises
I. Iodides to iodine
II. Sulphides to sulphur
III. Tin (IV) to tin (II)
IV. Iron (III) salts to iron (II) salts
The appropriate option with correct choices are
(a) I, II and III (b) II, III and IV
(c) I and IV (d) I and II

22. Gun metal contains
(a) Cu, Sn, Zn (b) Cu, Ni
(c) Cu, Ni, Fe (d) Cu, Sn, P

23. The total number of possible isomers of the complex compound $[Cu(NH_3)_4][PtCl_4]$ is
(a) 4 (b) 3 (c) 6 (d) 5

24. The coagulation values of $AlCl_3$ and NaCl are 0.093 and 52 respectively. Then coagulating power of $AlCl_3$ as compared to that of NaCl is
(a) 52×0.093 times (b) 52/0.093 times
(c) 0.093/52 (d) 52-0.093 times

25. The number of Nucleotide pairs present in one turn of DNA helix is
(a) 10 (b) 9 (c) 8 (d) 4

26. The end product (B) formed in the reaction sequence

$$\text{Glucose} \xrightarrow[H_3O^+]{HCN} A \xrightarrow[\Delta]{HI,P} B$$

(a) Hexanoic acid (b) Hexane
(c) Heptane (d) Heptanoic acid

27. In the oxyacids of chlorine Cl - O bond contains
(a) $p\pi - d\pi$ bonding
(b) $p\pi - p\pi$ bonding
(c) $d\pi - d\pi$ bonding
(d) None of these

28. The term "fools gold" is used for a mineral which shines like gold. It is
(a) Iron pyrites (b) Copper pyrites
(c) Cinnabar (d) Cadmium sulphide

29. Which process of reduction of mineral to the metal is suited for the extraction of copper from its ores with low copper content ?
(a) Metal displacement
(b) Auto reduction
(c) Chemical reduction
(d) Electrolytic reduction

30. Which of the following layering pattern will have a void fraction of 0.26?
(a) ABCCBABC (b) ABBAABBA
(c) ABCABCABC (d) ABCAABCA

ANSWER KEY

1. c	2. c	3. c	4. c	5. d
6. d	7. a	8. d	9. c	10. a
11. d	12. c	13. a	14. c	15. d
16. d	17. a	18. c	19. d	20. a
21. d	22. c	23. d	24. b	25. a
26. c	27. a	28. b	29. b	30. c

HINTS & SOLUTIONS

2.Sol: CaO, SO_3, Al_2O_3

3.Sol: In SCl_4,
number of bond pairs = 4
number of lone pairs = 1
In CCl_4,
number of bond pairs = 4
number of lone pairs = 0
In XeF_4,
number of bond pairs = 4
number of lone pairs = 2

4.Sol: F^- forms H-bond with HF, therefore, the species $[H....F-H]^-$ or HF_2^- exists.

5.Sol: $V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{5 \times 1.75}{400} \times \frac{360}{1} = 7.875L$

Percentage escaped

$$= \frac{7.875 - 2.875}{7.875} \times 100 = 63.5\%$$

6.Sol: $n_{H_2} = \frac{20}{2}$ $n_{O_2} = \frac{80}{32}$

$$p_{H_2} = \frac{n_{H_2}}{n_{H_2} + n_{O_2}} \times P.$$

7.Sol: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

1	0
$1-\alpha$	2α

$$\therefore \sum n = 1 + \alpha$$

$$K_P = \frac{4\alpha^2 P}{1-\alpha^2} = \frac{4(0.35)^2(1)}{1-(0.35)^2} = 0.56atm$$

$$\frac{1+\alpha}{1} = \frac{(MW_{Mixture})_{Initial}}{(MW_{Mixture})_{Final}} = \frac{(MW_{N_2O_4})}{(MW_{Mixture})_{Final}}$$

$$1 + 0.35 = \frac{92}{(MW_{Mixture})_{Final}}$$

$$MW_{Mixture} = 68.15$$

Let, V(mL) be the volume of mixture diffused in.
From Graham's law of diffusion,

$$\frac{r_{O_2}}{r_{Mixture}}\sqrt{\frac{MW_{Mixture}}{MW_{O_2}}} \Rightarrow \frac{20/10}{V/10}=\sqrt{\frac{68.15}{32}}$$

$V = 13.70mL$

8.Sol: rate $= k[A]^1$

$$k = \frac{2.0\times10^{-5}}{0.01} = 2.0\times10^{-3}$$

$$\therefore\ t_{1/2} = \frac{0.693}{2.0\times10^{-3}} = 347\ s$$

9.Sol: Molecularity can never be fractional.

10.Sol: $C_v = 0.075\times40 = 3\ cal\ K^{-1}\ mol^{-1}$

$C_p - C_v = R$

$\Rightarrow\ C_p - 3 = 2 \Rightarrow C_p = 5\ cal\ K^{-1}mol^{-1}$

$$\gamma = \frac{C_p}{C_v} = \frac{5}{3} = 1.66$$

Thus, the gas is monoatomic.

12.Sol: Mass percentage of solute in the solution

13.Sol: $K_a = C\alpha^2 = 0.1\times\left(\frac{7}{380.8}\right)^2 = 3.38\times10^{-5}$

16.Sol: Due to symmetrical structure, p-dichlorobenzene fits closely in the crystal lattice.

17.Sol:

$$\underset{\text{alcohol}}{R-OH} + \underset{\text{cerric amine. nitrate}}{(NH_4)_2Ce(NO_3)_6} \longrightarrow \underset{\text{yellow ppt.}}{Ce(NO_3)_6(ROH)_9} + N_2 + 14NO_3$$

20.Sol: Lithopone is used as paint.

21.Sol: Acidified potassium dichromate oxidises iodides to iodine, sulphides to sulphur, tin (II) to tin(IV), iron (II) salts to iron (III).

23.Sol: The possible isomers of the complex are

$[Cu(NH_3)_3Cl][PtCl_3NH_3]$,

$[Cu(NH_3)_2Cl_2][Pt(NH_3)_2Cl_2]$,

$[Cu(NH_3)Cl_3][Pt(NH_3)_3Cl]$

$[CuCl_4][Pt(NH_3)_4]$

The total number of isomers is five.

24.Sol: $\dfrac{\text{Coagulation power of } AlCl_3}{\text{Coagulation power of } NaCl}$

$$= \frac{\text{Coagulation value of } NaCl}{\text{Coagulation value of } AlCl_3}$$

26.Sol: Compound A is glucose cyanohydrin. Compound B is Heptane.

27.Sol:

$$\underset{d\pi}{\underset{\downarrow}{Cl}} \ — \ \underset{p\pi}{\underset{\downarrow}{O^-}}$$

Oxygen doesn't have vacant "d" orbitals in the valence shell and only $p\pi$ electron participates and chlorine has vacant "d" orbital in valences shell thus only $d\pi$ electron participates.

28.Sol: Copper pyrites or chalcopyrite $(CuFeS_2)$ is known as fools gold.

29.Sol: Auto reduction is used for the extraction of copper from its ore with low copper content.

Previous year JEE MAIN Questions

COORDINATION COMPOUNDS

[ONLINE QUESTIONS]

1. Identify the correct trend given below: **[2016]**

(Atomic No.: $Ti = 22, Cr = 24$ and $Mo = 42$)

(a) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$

(b) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$

(c) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$

(d) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$

2. Which one of the following complexes will consume more equivalents of aqueous solution of $Ag(NO_3)$? **[2016]**

(a) $Na_3[CrCl_6]$ (b) $[Cr(H_2O)_5Cl]Cl_2$

(c) $[Cr(H_2O)_6]Cl_3$ (d) $Na_2[CrCl_5(H_2O)]$

3. Which of the following is an example of homoleptic complex? **[2016]**

(a) $[Co(NH_3)_4Cl_2]$ (b) $[Co(NH_3)_6]Cl_3$

(c) $[Co(NH_3)_5Cl]Cl_2$ (d) $[Pt(NH_3)_2Cl_2]$

4. When concentrated HCl is added to an aqueous solution of $CoCl_2$, its colour changes from reddish pink to deep blue. Which complex ion gives blue colour in this reaction? **[2015]**

(a) $[CoCl_6]^{3-}$ (b) $[CoCl_6]^{4-}$

(c) $[Co(H_2O)_6]^{2+}$ (d) $[CoCl_4]^{2-}$

5. Which of the following complex ions has electrons that are symmetrically filled in both t_{2g} and e_g orbitals? **[2015]**

(a) $[FeF_3]^{3-}$ (b) $[CoF_6]^{3-}$

(c) $[Co(NH_3)_6]^{2+}$ (d) $[Mn(CN)_6]^{4-}$

6. Nickel (Z = 28) combines with a uninegative monodentate ligand to form a diamagnetic complex $[NiL_4]^{2-}$. The hybridisation involved and the number of unpaired electrons present in the complex are respectively: **[2014]**

(a) sp^3, zero (b) sp^3, two

(c) dsp^2, one (d) dsp^2, zero

7. An octahedral complex with molecular composition $M.5NH_3.Cl.SO_4$ has two isomers, A and B. The solution of A gives a white precipitate with $AgNO_3$ solution and the solution of B gives white precipitate with $BaCl_2$ solution. The type of isomerism exhibited by the complex is: **[2014]**

(a) Geometrical isomerism (b) Coordinate isomerism
(c) Ionisation isomerism (d) Linkage isomerism

8. Which of the following name formula combinations is not correct ? **[2014]**

Formula	Name
(a) $K[Cr(NH_3)_2Cl_4]$	Pottassium diamine Tetrachlorochromate III
(b) $[CO(NH_3)_4(H_2O)I]SO_4$	Tetraamine aquaiodo cobalt (III) sulphate
(c) $[Mn(CN)_5]^{2-}$	Pentacynomagnate (II) ion
(d) $K_2[Pt(CN)_4]$	Potassium tetracyanoplatinate (II)

9. Consider the coordination compound, $[Co(NH_3)_6]Cl_3$. In the formation of this complex, the species which acts as the Lewis acid is : **[2014]**

(a) NH_3 (b) CI^-
(c) $[Co(NH_3)]^{3+}$ (d) Co^{3+}

10. The correct statement about the magnetic properties of $[Fe(CN)_6]^{3-}$ and $[FeF_6]^{3-}$ is : (Z=26). **[2014]**

(a) $[Fe(CN)_6]^{3-}$ is paramagnetic, $[FeF_6]^{3-}$ is diamagnetic.
(b) Both are diamagnetic
(c) $[Fe(CN)_6]^{3-}$ is diamagnetic, $[FeF_6]^{3-}$ is paramagnetic.
(d) Both are paramagnetic

ANSWER KEY

1. a	2. c	3. b	4. d	5. a
6. d	7. c	8. c	9. d	10. d

HINTS & SOLUTIONS

1. Sol: $\Delta_o \propto$ CFSE (Crystal field stabilisation energy)

Δ_o of $[Cr(H_2O)_6]^{2+} < \Delta_o$ of $[Mo(H_2O)_6]^{2+}$

Because here Δ_o depends on Z_{eff} & Z_{eff} of 4d series is more than 3d series.

But Δ_o of $[Ti(H_2O)_6]^{3+} < \Delta_o$ of $[Ti(H_2O)_6]^{2+}$

2. Sol: Complex $[Cr(H_2O)_6]Cl_3$ will consume more equivalents of aqueous solution of $Ag(NO_3)$.

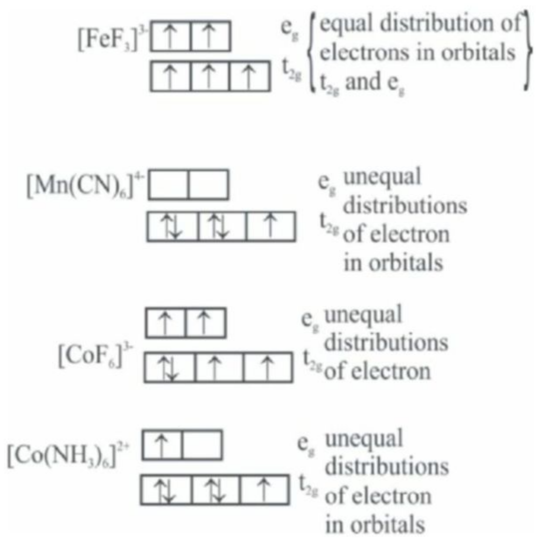
3.Sol: Complex having only 1 type of ligands are examples of homoleptic complex.

4.Sol: Aqueous of solution of $CoCl_2$ contains $[Co(H_2O)_6]^{2+}$ which is pinkish in colour so option d is incorrect.

Reduction potential of $Co^{3\oplus} \rightarrow Co^{2\oplus}$ is high so option (b) is incorrect. Co^{2+} does not oxidise easily to Co^{3+}.

It a general case that symmetrial substituted octahedral complexes are less deeper in colour than tetrahedral complexes. So $[CoCl_4]^{2-}$ is deep blue in colour.

5.Sol: Symmetrically filled t_{2g} and e_g are those which contain equal distribution of electrons.



8. Sol: Correct Name of $[Mn(CN)_5]^{2-}$ is Pentacynomagnate (III) ion.

9. Sol: Metalcation i.e., Ca^{3+} acts as a lewis acid which accept lone pair from ligands of NH_3.

10.Sol: In $[FeF_6]^{3-}$, 5 unpaired electron present.

In $[Fe(CN)_6]^{3-}$ 1 unpaired electron present.

CHEMIS TRICKS

By: A.N.S. SANKARA RAO (Hyderabad)

Some of the competitive exams are either based on only XII class syllabus or based on maximum questions from XII class syllabus. You have enjoyed with XI class shortcuts, memory tips and chemistricks in February 2019 issue, now you will get XII class in this issue.

SOLID STATE

- Contributuion of an atom at body centre =1, face centre $=\frac{1}{2}$, edge $=\frac{1}{4}$, corner $=\frac{1}{8}$

Net No. of constituent particles in

→ Simple unit cell $= 8\times\frac{1}{8}$ (corners) $=1$

→ F. C. C. unit cell $= 8\times\frac{1}{8}$ (corners) $+6\times\frac{1}{2}$ (faces) $=4$

→ B. C. C. unit cell $= 8\times\frac{1}{8}$ (corners) $+1\times1$ (Body) $= 2$

→ End centre unit cell= $= 8\times\frac{1}{8}$ (corners) $+2\times\frac{1}{2}$ (faces) $= 2$

CHEMISTRICK for 7 crystal systems CUTE ORTHE TRY MONDAY. If she slaps **TRYCLINIC**

Crystal System	Axial Characteristics	Angular Characteristics	No. of Bravais Lattices	No. of Lattices	Examples
CUBIC	$a=b=c$	$\alpha=\beta=\gamma=90°$	3	S, B, F	NaCl, CaF_2 ZnS, Diamond
TETRAGONAL	$a=b\neq c$	$\alpha=\beta=\gamma=90°$	2	S, B	SnO_2, TiO_2
ORTHO-RHOMBIC	$a\neq b\neq c$	$\alpha=\beta=\gamma=90°$	4	S, B, F,E	Match Box, KNO_3, $BaSO_4$, $MgSO_4.7H_2O$
HEXAGONAL	$a=b\neq c$	$\alpha=\beta=90°$ $\gamma=120°$	1	S	Graphite, Ice, Quartz, HgS
TRIGONAL	$a=b=c$	$\alpha=\beta=\gamma\neq 90°$	1	S	$NaNO_3$, $KMnO_4$, Bi, As, Sb
MONOCLINIC	$a\neq b\neq c$	$\alpha=\beta\neq\gamma=90°$	2	S, E	$FeSO_4.7H_2O$, $CaSO_4.2H_2O$
TRICLINIC	$a\neq b\neq c$	$\alpha\neq\beta\neq\gamma\neq 90°$	1	S	$CuSO_4.5H_2O$ Boric acid, $K_2Cr_2O_7$

S = Simple cubic or primitive,
F = FCC, B = BCC, E = End centred
CHEMISTRICK for No. of Bravias lattices :
Reading 3 to (2) 4 is not enough, Read from 11 to (2) 1.

- Radius ratio $= r_{cation} / r_{anion}$

Radius ratio	Shape of the crystal	Coordination number
upto 0.1	Linear	2
0.1 to 0.2	Trigonal	3
0.2 to 0.4	Tetrahedral	4
0.4 to 0.7	Square planar	4
0.4 to 0.7	Octahedral	6
> 0.7	Cubic	8

- n atoms = n Octahedral Voids
  = 2n Tetrahedral voids

O — One / Octahedral voids   T — Two / Tetrahedral voids

- Radius ratio of

Tetrahedral voids $= \dfrac{r_{Void}}{r_{Sphere}} = 0.225$

Octahedral Voids $= \dfrac{r_{Void}}{r_{Sphere}} = 0.414$

- Each unit cell of NaCl consists **14Cl⁻** ions & **13Na⁺** ions
- **Nearest neighbour distance (d):**

$$\text{Simple cubic : BCC : FCC} = a : \frac{\sqrt{3}}{2}a : \frac{1}{\sqrt{2}}\cdot a$$

$$= 1a : 0\cdot 86a : 0\cdot 7a$$

- **Radii (r):**

$$\text{Simple cubic : BCC : FCC} = \frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}\cdot a$$

$$= 0\cdot 5a : 0\cdot 43a : 0\cdot 35a$$

- **Packing fraction:**
  Simple cubic : BCC : FCC $= 0\cdot 52 : 0\cdot 68 : 0\cdot 74$
- **Packing efficiency:**
  Simple cubic : BCC : FCC $= 52\% : 68\% : 74\%$
- **Vacant space:**
  Simple cubic : BCC : FCC $= 48\% : 32\% : 26\%$

- Edge length of ***NaCl*** (FCC) $= 2(r_c + r_a) = a$
- Edge length of ***CsCl*** (BCC) $= 2(r_c + r_a) = \sqrt{3}\cdot a$
- HCP = AB AB AB......
- FCC or CCP = ABC ABC ABC ....
- SemiConductors P e n
  III IV V

***P*-type:** dope III (*B, Al*) with IV (*Si, Ge*)
***n*-type:** dope V (*P, As*) with IV (*Si, Ge*)
(e = equilibrium group IV i.e. middle of III & V)

- Density $(\rho) = \dfrac{Z \times M}{a^3 \times N_A}$

(Z = no. of atoms in unit cell, a = edge length)

- S — Shortage of ions / Schottky defect
  (NaCl, KCl, CsCl, **AgBr**)
- F — Fall into interstice / Frenkel defect
  (ZnS, AgCl, **AgBr**, AgI)
- $n\lambda = 2d\sin\theta$ (Bragg's equation)
- **F- Centres:** gives colour when anionic site is occupied by unpaired e^-
  → NaCl + **Na** (excess) : **Y**ellow
  → LiCl + **Li** (excess) : **P**ink
  → KCl + **K** (excess) : **V**iolet

CHEMISTRICK: K V Li P is **So**(sodium) **Y**ellow. Why?

- **Paramagnetic:** (B > H)
  eg: Cr^{+3}, Fe^{+2} & Fe^{+3}, Cu^{+2}, O_2
- **Diamagnetic:** (B <<<<< H)
  eg: H_2O, C_6H_6, ZnO, KCl, $NaCl$
- **Ferromagnetic:** (B >>>>> H) ↑↑↑↑↑↑
  eg: *Fe, Co, Ni*
- **Ferrimagnetic:** ↑↑↓↑↑↓
  eg: $CuFe_2O_4$, $ZnFe_2O_4$ like Ferrites
- **Anti Ferromagnetic:** ↑↓↑↓↑↓
  eg: V_2O_3, MnO_2

SOLUTIONS

- $ppm = \dfrac{No.\ of\ parts\ of\ one\ component}{No.\ of\ parts\ of\ all\ components} \times 10^6$

- $N = M \times Basicity(for\ acid)$
- $N = M \times Acidity(for\ base)$
- $M_{mix} = \frac{M_1V_1 + M_2V_2}{V_1 + V_2}$
- $N_{mix} = \frac{N_1V_1 + N_2V_2}{V_1 + V_2}$
- **Neutralisation:**

  $\frac{M_aV_a}{n_a} = \frac{M_bV_b}{n_b}$ $\qquad N_aV_a = N_bV_b$
- **Dilution:**

  $M_1V_1 = M_2V_2$ $\qquad N_1V_1 = N_2V_2$
- Vol. of Water added $= V_2 - V_1$
- No. of Milli moles $= M \times V$
- No. of moles $= \frac{M \times V}{1000}$
- No. of Milli equivalents $= N \times V$
- No. of equivalents $= \frac{N \times V}{1000}$
- Mole fraction of solvent $(X_1) = \frac{n_1}{n_1 + n_2}$
- Mole fraction of solute $(X_2) = \frac{n_2}{n_1 + n_2}$
- $X_1 + X_2 = 1$
- For aqueous solutions $X_{Solute} = \frac{n_2}{n_2 + 55\cdot 5}$
- $molality(m) = \frac{1000M}{1000d - M \cdot M_{Solute}}$
- $P_{gas} = K_H \cdot X_{gas}$ $\qquad K_H\ \alpha\ \frac{1}{\text{Solubility}}\ \alpha\ T$
- To prevent bends, scuba divers are filled with mixture contains 11.7% He + 56.2% N_2 + 32.1% O_2
- $P_{total} = X_1P_1^0 + X_2P_2^0$
- $\frac{P^0 - P}{P^0} = X_2 = \frac{n_2}{n_1 + n_2}$ (1=solvent, 2= solute)
- **Ideal solution** obeys **Raoult's law**,

  $\Delta V_{mix} = \Delta H_{mix} = 0$

  eg: $C_6H_6 + C_6H_5 - CH_3$, n-Hexane + n-Heptane,

  $C_2H_5Br + C_2H_5Cl$
- **+ve deviation:** $\Delta H > 0, \Delta V > 0$

  eg: $C_2H_5OH + CH_3COCH_3$,

  $C_2H_5OH + H_2O$, $CHCl_3 + CCl_4$
- **-ve deviation:** $\Delta H < 0, \Delta V < 0$

  eg: $C_6H_5OH + C_6H_5NH_2$, $CHCl_3 + CH_3COCH_3$
- **Azeotropes:** 95% C_2H_5OH + 5% H_2O,

  68% HNO_3 + 32% H_2O
- **No. of solute particles** $\propto$ B.P $\propto$ L.V.P $\propto$ T_b

  $\propto T_f \propto \frac{1}{V.P} \propto \frac{1}{F.P}$
- $\Delta T_b = T_b - T_0 = i \cdot K_b \cdot m$
- $\Delta T_f = T_0 - T_f = i \cdot K_f \cdot m$
- $\pi V = nTR$ (π = Osmotic pressure)
- π of 1 lit. soln of 1M = 22.4 atm (at 0^0C)
- $\pi_1 = \pi_2$ (**Isotonic** solution)
- Degree of **dissociation** $\alpha = \frac{i-1}{n-1}$
- Degree of **association** $\alpha = \frac{1-i}{1-\frac{1}{n}}$
- **Hypotonic solution:** **low** π, Haemolysis,

  $[salt] < 0\cdot 9\% \left(\frac{w}{w}\right)$, Water flow into cell & burst.
- **Hypertonic solution:** **high** π, plasmolysis,

  $[salt] > 0\cdot 9\% \left(\frac{w}{w}\right)$, Water flow out of cell & shrink.

ELECTRO CHEMISTRY

- Resistance $R = \rho \frac{l}{a} (units : ohm)$
- conductance $C = \frac{1}{R} = \frac{1}{\rho} \cdot \frac{a}{l} (ohm^{-1}\ or\ siemen)$
- Specific resistance or Resistivity

  $(\rho) = R \cdot \frac{a}{l}\ (ohm\ m)$

- Specific Conductance or Conductivity

$$(K)=\frac{1}{\rho}=\frac{1}{R}\cdot\frac{l}{a}=C\cdot\frac{l}{a}\quad(ohm^{-1}\ m^{-1})$$

- Molar Conductivity

$$(\Lambda_m)=\frac{K\times 1000}{M}\quad(ohm^{-1}\ m^{2}\ \ mol^{-1})$$

- Equivalent conductivity

$$(\Lambda_{eq})=\frac{K\times 1000}{N}\quad(ohm^{-1}\ m^{2}\ equivalent^{-1})$$

- $\Lambda_c=\Lambda_0-b\sqrt{c}$ (slope = $-b$, intercept = Λ_0)
- $\Lambda_m^0=V_+\ \lambda_+^0+V_-\ \lambda_-^0$ $\quad(V=no.\ of\ ions)$
- $\Lambda^0_{CH_3COOH}=\lambda^0_{CH_3COONa}+\Lambda^0_{HCl}-\Lambda^0_{NaCl}$

  (λ^0 = limiting molar conductance)
- $\Lambda^0_{eq}(BaCl_2)=\frac{1}{2}\lambda^0_{Ba^{+2}}+\lambda^0_{Cl^-}$
- $\Lambda^0_m(BaCl_2)=\lambda^0_{Ba^{+2}}+2\lambda^0_{Cl^-}$
- $\Lambda^0_m(NH_4OH)=\lambda^0_m(NH_4Cl)+\frac{1}{2}\lambda^0_m\left[Ba(OH)_2\right]-\frac{1}{2}\lambda^0_m(BaCl_2)$
- Solubility $(S)=\frac{K_{Salt}\cdot 1000}{\Lambda^0_m}$

- For cation electrode $E_{Cell}=E^0_{Cell}+\frac{0\cdot 059}{n}\log C$
- For Anion electrode $E_{Cell}=E^0_{Cell}-\frac{0\cdot 059}{n}\log C$
- For $Zn+2Ag^+(aq.)\rightarrow Zn^{+2}(aq.)+2Ag$

$$E_{Cell}=E^0_{Cell}+\frac{0\cdot 059}{n}\log\frac{\left[Ag^+\right]^2}{\left[Zn^{+2}\right]}$$

- $E_{Cell}=-0.059pH$ (for Hydrogen electrode at 25^0C)
- $\Delta G^0=-2.303RT\log K_C$

  $=-nFE^0_{Cell}$
- $E^0_{Cell}=\frac{0\cdot 059}{n}\log K_C$
- Thermodynamic efficiency of fuel cell $=\frac{\Delta G^0_m}{\Delta H^0_m}$
- **Products in electrolysis of aqueous electrolyte :** If **Cu, Ag, Au, Pt, halogens** are present we will get them, if not $\mathbf{H_2}$ at **cathode**, $\mathbf{O_2}$ at **anode** will be liberated.

  eg: aq.K_2SO_4 on electrolysis gives H_2 at cathode, O_2 at anode.

  aq.$CuSO_4$ gives Cu at cathode, O_2 at anode with Pt electrodes.

S.No.	Electrolyte	Cathode	Anode	At Cathode	At Anode
1.	K_2SO_4(aq)	Pt	Pt	H_2	O_2
2.	$MgCl_2$(fused)	Steel	Graphite	Mg	Cl_2
3.	NaCl(molten)	Pt	Pt	Na	Cl_2
4.	NaCl(aq)	Pt	Pt	H_2	Cl_2
5.	Al_2O_3(fused) cryolite	Graphite	Graphite	Al	O_2
6.	50% H_2SO_4(aq)	Pt	Pt	H_2	$H_2S_2O_8$

S.No.	Electrolyte	Cathode	Anode	At Cathode	At Anode
7.	$NiCl_2$(fused)	Pt	Pt	Ni	Cl_2
8.	$CuCl_2$(molten)	Pt	Pt	Cu	Cl_2
9.	$CuSO_4$(aq)	Pt	Pt	Cu	O_2
10.	$CuSO_4$(aq)	Pt	Cu	Cu	Cu_2
11.	$AgNO_3$(aq)	Pt	Pt	Ag	O_2
12.	$AgNO_3$(aq)	Pt	Ag	Ag	Ag^+
13.	NaOH(molten)	Pt	Pt	N_2	O_2
14.	NaOH(aq)	Pt	Pt	H_2	O_2
15.	NaH(molten)	Pt	Pt	Na	H_2
16.	RCOONa(aq)	Pt	Pt	H_2, NaOH (left solution)	R-R CO_2

- Faraday's 1st law $\boxed{m = c \cdot e \cdot t}$ $\quad e = \dfrac{E}{96500}$ **(TRICK: m = cet pronounce as EAMCET)**
- 1F=96,500C = can deposit 1Equivalent
- Faraday's 2nd law $\dfrac{W_1}{W_2} = \dfrac{E_1}{E_2}$
- **CHEMISTRICK** for **Electro Chemical Series** is

"**Li**po**Ba** (Potassium) (**K**ailum) **S**ir **Ca**ll **Na**turally (**Na**trium) (Sodium) while **Mag**ister**Al**l **Mn** are **Z**i**n**gy and **Cr**ossing

by **Fe**rry (boat). **Cad**et **Co**ach **Ni**tin (**Stan**num) leads (**Pl**um**b**um) **H**ighly **Cu**pid, **I**deal, mercy, (mercury) (**H**ydrar**g**yrum)

Silly (Silver) (**A**rgentum) **Br**oad minded, **Cl**ass **Au**gumentative **F**ellows"

- $S.R.P.(E^0)\ \alpha$ oxidising power

$$\alpha \frac{1}{reducing\ \ power}$$

- $E_{Cell} = E_{Right} - E_{left}$

To calculate E_{cell} problems easily follow the table:

S.NO	L.H.S (Anode)	R.H.S(Cathode)
1	high-*ve* S.R.P.	low -*ve* S.R.P.
2	low +*ve* S.R.P.	high+*ve* S.R.P.
3	only -*ve* S.R.P.	only +*ve* S.R.P.

- **Lead accumulator:**

$$Pb + PbO_2 + 2H_2SO_4 \underset{\text{Charging}}{\overset{\text{discharging}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$

CHEMICAL KINETICS

For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$

- rate $= -\dfrac{d[N_2]}{dt} = -\dfrac{1}{3}\dfrac{d[H_2]}{dt} = +\dfrac{1}{2}\dfrac{d[NH_3]}{dt}$
- rate $= k[N_2][H_2]^3$

- $k = A \cdot e^{-E_a/RT}$
- $\log \frac{k_2}{k_1} = \frac{E_a}{2 \cdot 303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$
- For zero order reaction $k = \frac{1}{t}\{[A]_0 - [A]\}$
- For 1st order reaction $k = \frac{2 \cdot 303}{t}\log\frac{a}{a-x}$
- Half life $\left(t_{\frac{1}{2}}\right)$ for zero order reaction $= \frac{[A]_0}{2k}$
- For 1st order reaction $t_{\frac{1}{2}} = \frac{0 \cdot 693}{k}$
- $\frac{t'_{\frac{1}{2}}}{t''_{\frac{1}{2}}} = \left(\frac{a''}{a'}\right)^{n-1}$
- $t_{50\%} : t_{75\%} : t_{87.5\%} : t_{93.75\%} = 1:2:3:4$
- $t_{90\%} : t_{99\%} : t_{99.9\%} : t_{99.99\%} = 1:2:3:4$
- Specific rate $k = P \cdot z \cdot e^{-E_a/RT}$
  (P= probability factor)
- $\Delta H = (E_a)_{forward\ reaction} - (E_a)_{backward\ reaction}$

SURFACE CHEMISTRY

- Freundlich adsorption isotherm $\frac{x}{m} = K \cdot P^{\frac{1}{n}}$

  ($\frac{1}{n}$ can have values 0 to 1)

  (Slope $= \frac{1}{n}$, intercept $= \log K$)
- Langmuir adsorption isotherm $\frac{x}{m} = \frac{aP}{1+bP}$
- Adsorption $\alpha\ T_C$
- For adsorption $\Delta H = -ve, \Delta S = -ve, \Delta G = -ve$
- **Amount of adsorption:**

  $SO_2 > NH_3 > CO_2 > CH_4 > N_2 > H_2$
- **Zeolites:** good shape selective catalysts, water softners
- **YEAST:** source of **Z**ymase, **I**nvertase, **M**altase enzymes

  TRICK: ZYM (ZIM) is in the **EAST (YEAST)**

S.No.	Enzyme	Source	Enzyme used in the reaction
I	Nuclease	Nucleus	DNA and RNA $\rightarrow$ Nucleotides
II	Insuline	Lever	Glucose $\rightarrow$ Glycogen
III	Lactic Dehydrogenose	Curd	Milk $\rightarrow$ Curd
IV	Trypsin	Intestine	Proteins $\rightarrow$ Amino acid
V	Tylene	Saliva	Starch $\rightarrow$ Maltose
VI	Lypase	Intestine	Lipid(fat) $\rightarrow$ Fatty acid and glycerides
VII	Pepsin	Stomach	Proteins $\rightarrow$ Amino acid
VIII	Urease	Soyabean	Urea $\rightarrow$ Ammonia and CO_2
IX	Maltase	Yeast	Maltose $\rightarrow$ Glucose
X	Diastase	Malt	Starch $\rightarrow$ Maltose
XI	Zymase	Yeast	Glucose $\rightarrow$ Ethyl alcohol and carbondioxide
XII	Invertase	Yeast	Sucrose $\rightarrow$ Glucose and Fructose

Dispersed phase	Dispersion medium	Designation	Examples
Gas	Gas	-	Unknown
Gas	Liquid	Foam	Foam, froth, soap lather, whipped cream, beaten egg white, beer, shaving cream
Gas	Solid	Solid foam	Occluded gases in metals, pumice stone, bread, foam rubber, styrene foam
Liquid	Gas	Aerosol	Clouds, fog, mist, insecticide sprays.
Liquid	Liquid	Emulsion	Milk, cream, certain medicines.
Liquid	Solid	Gel (Solid emulsion)	Curd, cheese, jellies, $Fe(OH)_3$, $Al(OH)_5$ butter, boot polish.
Solid	Gas	Solid foam (Aerosol)	Smoke, dust, fumes
Solid	Solid	Solid sol	Coloured glasses, coloured precious stones, rock salt, alloys
Solid	Liquid	Sol	Starch, proteins, As_2S_3 and gold solution, glue, Indian ink, muddy water, milk of magnesia.

- **Lyophilic sol (Solvent loving)**: gum, gelatin, starch, albumin
- **Lyophobic sol(Solvent hating):** gold sol, silver sol
- **Multi molecular colloids:** starch, cellulose, proteins, polymers
- **CMC for soap:** 10^{-3} *to* 10^{-4} mol/lit
- **+vely charged sols:** hydrated metallic oxides, TiO_2, haemoglobin, Methylene blue, basic dye
- **-vely charged sols:** Metals, Metal sulphides, Acid dyes, eosin, Congo red, starch, gum, gelatin, clay, charcoal
- Coagulating power α Charge on the ion
- **Gold Number:** The minimum number of milli grams of lyophilic colloid required to prevent the coagulation of a standard gold sol on addition of 1 ml of 10% NaCl Solution.

protective power $\alpha \dfrac{1}{gold\ number}$

- **Cause of Artificial rain:** AgI or electrified sand in contact with cloud
- **flocculation value** $\alpha \dfrac{1}{\text{Charge on ion}}$

eg: $KCl > MgCl_2 > CrCl_3 > SnCl_4$

GENERAL PRINCIPLES OF METALLURGY

- **Froth Collectors:** pine oil, sodium ethyl xanthate
- **Froth stabilizers**: Cresols, Aniline
- **Depressant:** NaCN (prevents ZnS from coming to froth, but PbS comes with froth)
- **Copper Matte:** More $Cu_2S + little\ FeS$
- **Metallurgical transformation:**

  $\Delta G = -ve,\ \Delta H = +ve,\ \Delta S = +ve$
- **Pig iron:** obtained from blast furnace, contains 4% C
- $2Cu_2O + Cu_2S \rightarrow SO_2 + 6Cu$ (**Blister copper**)
- **Refining by distillation:** Zn, Cd, Hg
  - → **Liquation:** Sn, Pb, Bi, Hg
  - → **Poling:** Cu
  - → **Cupellation:** Ag
  - → **Electrolytic refining:** Cu, Ag, Au, Al, Pb, Zn
  - → **Zone refining:** Ge, Si, B, Ga, In
  - → **Vapour phase refining:** Ni (**Mond's process**), Hf & Zr & Ti (**Van Arkel Method**)
- **Brass:** Cu (60 to 80%), Zn (40 to 20%)
- **Bronze:** Cu (75 to 90%), Sn (25 to 10%)

- **German silver:** Cu (25 to 30%), Zn (25 to 30%), Ni (40-50%)
- **% of C:** Pig iron (4%) > Cast iron(3%)>Steel(2.1%) > Wrought iron(0.08%)
- **Cryolite** (Na_3AlF_6)**:** lowers M.P., increases conductivity
  Fluorspar(CaF_2)**:** Decreases Fusion temperature.

p- Block Elements

15 th group:

- Stability, Basic Nature, Bond Angle:
  $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
- **M.P:** $NH_3 > SbH_3 > AsH_3 > PH_3$
- **B.P:** $SbH_3 > NH_3 > AsH_3 > PH_3$
- **Hydrolysis** of P_4O_6 or PCl_3 gives H_3PO_3
- **Hydrolysis** of P_4O_{10} or PCl_5 gives H_3PO_4
- **Anhydride** of H_3PO_4 is: P_4O_{10} & H_3PO_3 is : P_4O_6
  $(TRICK: 4H_3PO_4 - 6H_2O = P_4O_{10})$
  $(4H_3PO_3 - 6H_2O = P_4O_6)$
- **Nessler's reagent:** $K_2[HgI_4]$
  a mixture of KI, $NaOH$, $HgCl_2$
- **Brown ring:** $[Fe(H_2O)_5NO]SO_4$ Where oxi. state of $Fe = +1$
- IUPAC name of brown ring: penta aqua Nitrosonium Iron (I) Sulphate
- **Aquaregia:** conc HNO_3 : $con\ HCl$ in 1 : 3 ratio
- **Nitrolim:** $CaCN_2$ +graphite (used as fertilizer)
- NH_3 **dried** over: CaO (quick lime)
- **Heating** of $Pb(NO_3)_2$ gives O_2, NO_2, PbO;
  NH_4NO_3 gives N_2O; NH_4NO_2 gives N_2;
  N_2O_3 gives NO & NO_2.
- **Smoke screens & Holme's signals:** combustion of PH_3 (produced by CaC_2 & CaS).
- **dil.HNO_3** reacts with **Cu** to give **NO** whereas ***Zn*** gives **N_2O**
- **Con.HNO_3** reacts with Cu, Zn, I_2, C, S_8, P_4 gives **NO_2** along with $Cu(NO_3)_2$, $Zn(NO_3)_2$, HIO_3, CO_2, H_2SO_4, H_3PO_4.
- Meta phosphoric acid exists in polymeric form $(HPO_3)_n$ only

16 th group

- **Electron gain enthalpy:** $S > Se > Te > Po > O$
- **Electronegativity:** $O > Se > S > Te > Po$
- **Thrust** in rockets given by combustion of **Hydrazine** in liquid O_2
- **Oxi.agent** in the manufacture of KMnO4 is O_3
- SO_2 is **Antichlor, disinfectant, preservative**
- **As** impurities purified by gelatinous **Fe_2O_3**
- **O_3** oxidises NO_2^- to NO_3^-, SO_3^{-2} to SO_4^{-2},
  NO to NO_2, SO_2 to SO_3,
  HX to X_2 (not HF), PbS to $PbSO_4$, Moist
  I_2 to HIO_3, Hg to Hg_2O (tailing of Hg)
- For decomposition of O_3 :
  $\Delta H = \Delta G = -ve \qquad \Delta S = +ve$

- **Oxo Acids of S:**

Thinking order	Writing order	Formula	Name of the acid
(2)	1.	H_2SO_3	Sulphurous acid (+4)
(1)	2.	H_2SO_4	Sulphric acid (+6)
(3)	3.	H_2SO_5	PeroxoMono Sulphuric acid (+6)
(5)	4.	$H_2S_2O_2$	Thionous acid (-2, +4)
(7)	5.	$H_2S_2O_3$	Thionic acid (-2, +6)
(6)	6.	$H_2S_2O_4$	Di Thionous acid (+3, +3)
(10)	7.	$H_2S_2O_5$	Pyro Sulphurous acid (+3, +5)
(8)	8.	$H_2S_2O_6$	Di thionic acid (+5, +5)
(11)	9.	$H_2S_2O_7$	Pyro Sulphuric acid (+6, +6)
(4)	10.	$H_2S_2O_8$	Peroxo di sulphuric acid (+6, +6)
(9)	11.	$H_2S_{n+2}O_6$	Poly thionic acid(0, +5)

- Charring of sugar is dehydration reaction
  $C_{12}H_{22}O_{11} \xrightarrow{conc.H_2SO_4} 12C + 11H_2O$
- Cyclic trimer of SO_3 has $6S=0$ & $3\ S-O-S$ bonds

17th GROUP

- **Oxidising power:** $Cl_2O > ClO_2 > Cl_2O_6 > Cl_2O_7$
- **Acidic Nature:** $Cl_2O_7 > Cl_2O_6 > ClO_2 > Cl_2O$
- **Bond angle:** $HClO_2 > HClO_4 > HClO_3 > HClO$
  (111^0) $(109 \cdot 5^0)$ (106^0) (90^0)
- **reducing power:** $I^- > Br^- > Cl^-$
- **Acid strength** of oxyacid α No. of **Oxygens**
- **Acid strength**: $H_2Se > HI > HBr$
- **pseudohalide:** CN^-
- **Tincture of Iodine:** alcoholic Solution of I_2
- **Iodised salt prepared from**: KI & KIO_3
- **Spent Nuclear fuel** PuF_6 **removed by:** O_2F_2
- **Bleaching agent in paper industry:** $Cl\,O_2$
- **CO can be estimated by:** I_2O_5
- **Bond disso. energy:** $Cl_2 > Br_2 > F_2 > I_2$
- **Litmus paper** is **decolourised** by chlorine water due to **bleaching action** of $HOCl$.
- XX_3' are Bent T-shaped, XX_5' are square pyramidal
- **Poisonous gases:** phosgene $(COCl_2)$, tear gas (CCl_3NO_2), mustard gas $(Cl\,CH_2CH_2)_2S$
- reaction of Cl_2 with cold, **dil NaOH** gives NaCl, **NaOCl**, but hot, **conc.NaOH** gives NaCl & **NaClO$_3$**.
- enrichment of **U^{235}** is done by **ClF$_3$** or **BrF$_3$**.

18th GROUP

- **He** can diffuses through rubber, glass, plastic
- liquid ***He*** used in: Nuclear reactors, NMR, MRI.
- $XeF_2 + 2H_2O \rightarrow 4HF + 2Xe + O_2$
  $6XeF_4 + 12H_2O \rightarrow 24HF + 4Xe + 2XeO_3 + O_2$
  $XeF_6 + 1H_2O \rightarrow 2HF + XeOF_4$
  $XeF_6 + 2H_2O \rightarrow 4HF + XeO_2F_2$
  $XeF_6 + 3H_2O \rightarrow 6HF + XeO_3$
- Mixture of ***O_2+He***: used by deep sea divers & asthma patients
- Solubility & ease of liquifaction & enthalpy of vaporisation **:** $Xe > Kr > Ar > Ne > He$
- % of **d** character: $XeF_6 > XeF_4 > XeF_2$
- ***Rn*:** used in the treatment of cancer
- ***Ne*:** used in Beacon lights, decorative discharge tubes
- ***Kr*-85:** used in electronic tubes
- ***Ar+Hg* Vapour:** used in fluoroscent tubes
- $C_p/C_v = 1.66$ for noble gases (Mono atomic)

compound	No. of Lone pairs	No. of σ bonds	No. of π bonds	Hybridization
XeF_2	3	2	0	sp^3d^1
XeF_4	2	4	0	sp^3d^2
XeF_6	1	6	0	sp^3d^3
XeO_3	1	3	3	sp^3
XeO_4	0	4	4	sp^3
$XeOF_4$	1	5	1	sp^3d^2
XeO_2F_2	1	4	2	sp^3d^1
$XeOF_2$	2	3	1	sp^3d^1

CHEMISTRICK:

No. of L.P.S $= \dfrac{G-(No.\ of\ \ F+2\times oxygens)}{2}$

No. of σ $= No.\ of\ \ F + No.\ of\ \ oxygens$

No. of π $= No.\ of\ oxygens$

d & f BLOCK ELEMENTS & CO-ORDINATION COMPOUNDS

CHEMISTRICK "**Sc**an**Ti** **V**ecro **M**a**n** **ICoNi** **CuZ**im"
(Sc, Ti, V, Cr, Mn, I = Iron **Fe**rrum, Co, Ni, Cu, Zn)

- $\mu = \sqrt{n(n+2)}$ B.M.
- $\mu = n + 0.7\ or\ 0.8\ or\ 0.9.$
  n = no. of electrons $= \mu - 0.7\ or\ 0.8\ or\ 0.9$
- E.A.N.= Z - oxi.No. + 2× unidentate ligands
- $\Delta_t = \dfrac{4}{9}\Delta_0$
- If $\Delta_0 > P$ (Weak field ligands) if $4e^-$ are there $t_{2g}^4 e_g^0$

- If $\Delta_0 < P$ (strong field ligands) if $4e^-$ are there $t_{2g}^3 e_g^1$
- **Weak field ligands:** H_2O, halides, OH^-, S^{-2}, $C_2O_4^{-2}$ can form **outer orbital complex** with formula ***ns^x np^y nd^z***
  (Where $x + y + z$ = coordination Number) (n = principal quantum number)
  eg: $[CoF_6]^{-3} = s^1p^3d^2$
- **Strong field ligands:** NCS^-, en, CN^-, CO can form **inner orbital complex** with formula ***$(n-1)d^x ns^y np^z$***
- **Note**: some times x could be zero
  eg: $[Fe(CN)_6]^{-4} = d^2s^1p^3$
- **Spectro chemical series** (order of Δ or CFSE):
  $I^- < Br^- < S^{-2} < SCN^- < Cl^- < N^{-3} < F^-$
  $< OH^- < C_2O_4^{-2} < H_2O < NCS^- < NH_3$
  $< en < CN^- < CO$
- Overall stability constant $\beta_n = K_1 \cdot K_2 \cdots K_n$
- Instability constant $= \dfrac{1}{\beta_n}$

CHEMISTRICK for 14 Lanthanoids
"**LaCe** is **Pr**edominantly **N**ee**d**ed to **Pr**o**m**ote **S**a**m**e **Eu**ropean **Gd**'s **T**erri**b**le, **Dy**namic, **Ho**nourable **Er**ratic **T**o**m**m**Yb**L**u**e".

POLYMERS

S.No	Polymer	Monomers	Special features
1.	Nylon-6 (perlan-L)	Caprolactam	polyamide, condensation, homopolymer
2.	Nylon 6, 6	adipic acid & hexamethylene diamine	polyamide, condensation, copolymer, fibre
3.	Nylon-2 Nylon-6	glycine & caproic acid	polyamide, condensation, copolymer, Biodegradable
4.	PHBV	3-hydroxy butanoic acid, 3- hydroxy pentanoic acid	polyamide, condensation, copolymer, Biodegradable
5.	Bakelite	Phenol & HCHO	polyamide, copolymer, **Novolac (initial product)**
6.	Terylene (Dacron/PET)	Terepthalic acid & ethylene glycol	polyster, fiber, condenstion, copolymer
7.	Teflon	Tetra Fluoro ethene	HDPE, homopolymer, Non sticky, addition
8.	Neoprene	Chloreprene	homo, addition, elastomer, synthetic rubber
9	Buna - N	1, 3 Buta diene, Acrylonitrile (vinyl cyanide)	Elastomer, synthetic rubber, copolymer
10.	Buna - S	1, 3 Buta diene, styrene	Elastomer, synthetic rubber, copolymer
11.	Poly Acrylonitrile	Vinyl cyanide	Addition, homopolymer, HDPE, present in fibres like orlon, acrilan
12.	Glyptal	Ethylene glycol & Pthalic acid	condensation, polyester, copolymer, used in paints

- **Ziegler Natta catalyst:**
  $(C_2H_5)_3Al + TiCl_4$ used to get HDPE
- $PDI = \frac{\overline{M}_w}{\overline{M}_n}$

BIOMOLECULES

CHEMISTRICK: Mono remala weds **Noresu**
Reducing sugars: maltose, lactose, all mono saccharides
Non reducing sugars: sucrose
Anomers: $\alpha - D$ glucose & $\beta - D$ glucose
Glycogen: structure is similar to amylopectin, highly branched present in liver, brain, muscles, yeast, fungi.

- Essential Amino acids: obtained through diet **(CHEMISTRICK TV FILM WHRK is essential)** they are Threonine, Valine, F-phenyl alanine, Isoleucine, Methionine, W- trypophan, Histidine, R-Arginine, K-Lysine
- Proline has secondary amino (imino) group
- **Except glycine** all **other natural amino acids** are **optically active**.
- Peptide bonds are present in **proteins** & **enzymes**
- **Insulin** Contain 51 amino acids
- Insulin, albumins, haemoglobin, enzymes are **globular proteins**
- 2^0, 3^0 - structure of **proteins**: consists **H**-bonds, **- S - S -** bonds, **electrostatic** forces of attraction and **Van der Waals forces**.
- During **denaturation** of proteins only 2^0 & 3^0 structures are **destroyed**
- **expect B$_{12}$** others B_1, B_2, B_6 are excreted in urine

CHEMISTRICK U R TireD
CAGU : RNA
CAGT : DNA
Purine bases: Adenine (A), Guanine (G)
Pyramidine bases: Cytosine (C), Uracil (U), Thymine (T)
CHEMISTRICK: CUT the **Pyramid**

- **Nucleoside:** Base + Pentose sugar
- **Nucleotide:** Base + Pentose sugar + Phosphate
- **Steroid hormones:** estrogens, androgens
- **Poly peptide hormones:** glucagon, insulin, endorphins
- **Amino acid derivative hormones:** Thyroxine [contains iodine], epinephrine, norepinephrine
- **Insulin:** decrease the glucose level (by converting glucose to glycogen)
- **Glucagon:** increase the glucose level **into** glycogen

Low level of thyroxine: Leads to **hypothyroidism** (lethargyness & obesity)
Characters of **Addison's disease**: stress, weakness, hypoglycemia

- **Hormone produced during stress:** Adrenaline
  Sucrose = $\alpha - D$ - glucopyranose + $\beta - D$ - fructotfuranose
- **Mutarotation:** exhibited by reducing sugars (in hemiacetal & hemiketal forms)
- **Chirality of DNA & RNA:** due to D-sugar content

H — Helical structure of protein
H — Hydrogen bonding

No of Chiral Carbons in $\alpha - or\ \beta - D -$ glucose: 5
In **DNA**: **A = T**; **G = C**

- Complimetary strand of **TATGACTG** of **DNA** is **ATACTGAC**; **RNA** is **AUACUGAC**

CHEMISTRY IN EVERYDAY LIFE

- **Deltol:** Mixtrue of Terpineol & Chloroxylenol, used as antiseptic
- **Antiseptic:** Bithional, 0.2% phenol
- **Stable artificial sweetener:** Alitame
- **Antihistamines:** Diphenyl hydramine, promethazine, brompheniramine (Dimetapp), terfenadine (seldane)
- **Tranquilisers:** Valium, Equanil, noradrenaline, Luminal, seconal
- **Aspirin:** Acetylation product of O-hydroxy benzoic acid, it is **antipyretic** & **analgesic**
- **Antacids:** $NaHCO_3$, $Al(OH)_3$, $Mg(OH)_2$, omeprazole, **Lansoprazole**, **Ranitidine (zantac)**
- **Analgesics:**
  → **Non-Narcotic:** Novalgin, Aspirin, Ibuprofen
  → **Narcotic:** Morphine, Heroin, Codeine
- **Antibiotics:** (Salvarsan, Prontosil, Sulphanilamide, Azo dye)
  → **Bactericidal:** ofloxacin, pencillin
  → **Bateriostatic:** Tetracycline, chloramphenicol, erythromycin
- **Antiseptics:** Dettol, SO_2, 0.2% phenol, Cl_2, Bithional, H_2O_2, Boric acid, CHI_3
- **Antifertility drugs:** Norethindrone, Novestrol, Mifepristone
- **Anti oxidants:** BHT, BHA, SO_2
- **Food preservatives:** Sugar, Vegetable oils, NaCl, C_6H_5COONa
- **Order of Sweetness of Artificial Sweeteners:** Alitame > Sucrolose > Saccharin > Aspartame

- **Scum:** Insoluble soap $(C_{17}H_{35}COO)_2Ca$ or Mg
- **Shaving Soap:** glycerol + rosin
- **Laundry Soap:** sodium rosinate + sodium silicate + Sodium carbonate + Borax
- **Anionic detergent:** sodium lauryl sulphate
- **Cationic detergent:** Cetyltrimethyl Ammonium bromide (present in hair conditioner)
- **Non ionic detergent:** Liquid dish washing detergent
- **Biodegradable detergent:** unbranched hydrocarbons
- **Non biodegradable detergent:** branched hydrocarbons

ORGANIC CHEMISTRY

Orders:

- **Dipole moment:**

  $CH_3Cl > CH_3F > CH_3Br > CH_3I$
- **B.P.:** **Ph**enol > **Wa**ter > **al**cohol (**CHEMISTRICK:** The **great pheno Waal** like the **great china wall**)
- **B.P.** of dichloro Benzene: $o > p > m$

  M.P. of dichloro Benzene: $p > o > m$
- **SN¹:**

  $3^0\,RX > 2^0\,n-butylX > 2^0\,isobutylX > 1^0\,RX$

  SN²:

  $3^0\,RX < 2^0\,n-butylX < 2^0\,isobutylX < 1^0\,RX$
- **SN¹:**

  $Ar_2CRX > Ar_2CHX > ArRCHX > ArCH_2X$

  SN²:

  $Ar_2CRX < Ar_2CHX < ArRCHX < ArCH_2X$

  (R = alkyl, Ar = (C_6H_5) Aryl, X = halide)

  CHEMISTRICK **T**wo **In** **O**ne (SN^2- **I**nversion- **O**ne step)
- Order of **dehydration** of alcohols: $3^0 > 2^0 > 1^0$
- Order of **reactivity** of alcohols with HX:

  $3^0 > 2^0 > 1^0$
- Order of reactivity

  (1) $RCOCl > (RCO)_2O > RCOOR > RCOOH > RCONH_2$

  (2) Alkene > alkyne > alkane

  (3) $RCHO > RCOR$
- **Acidic nature**

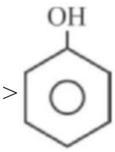
(1) picric acid > 3, 5 dinitro phenol > *o* - nitro phenol > m- nitro phenol > phenol > *m* - cresol > *p*- cresol > *o* - cresol

(2) $1^0-OH > 2^0-OH > 3^0-OH$

(3) *p*- nitro phenol > *o* - nitrophenol > *m*-nitrophenol > Phenol.

(4) $C_6H_5COOH > C_6H_5CH_2COOH > CH_3COOH > C_2H_5COOH$

(5) $-CF_3 > -NO_2 > -CN > -F > -Cl > -Br > -I > -C_6H_5$

(6) $p- > o- > m->$  $> m- > p- > o-$

(e^-. W. D. groups are substituted) (e^-. Donating groups are substituted)

Basic Nature:

(1) In gaseous state:

$3^0-NH_2 > 2^0-NH_2 > 1^0-NH_2 > NH_3$

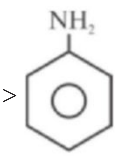
(2) In aqueous state:

$R_2NH > RNH_2 > ArCH_2NH_2 > NH_3 >$

$ArNHR > ArNH_2 > ArNR_2$

(3) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

(4) $(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2 > NH_3$

(5) $p- > o- > m->$  $> m- > -p- > o^-$

(e^-. Donating groups are substituted) (e^-.W.D. groups are substituted)

(6) $R_2NH > RNH_2 > R_3N > ArCH_2NH_2 > NH_3$

$> ArNR_2 > ArNHR > ArNH_2 > Ar_2NH > Ar_3N$

$R = CH_3 \qquad Ar = C_6H_5$

- ***-Cl*** is $o-\&\,p-$directing

  But ***-NO₂*** group shows its effect only at *o*- and *p*- positions (though it is *m*-directing)
- In ***coupling*** BDC reacts with Phen**O**l to give **O**range dye, whereas **An**iline gives An yellow dye
- **Ozonolysis:** break = bond or ≡ bond put oxygen before & after the bond to get the products.

- Names of series of Oxyacids in order:
  CHEMISTRICK OMSGAP,
  Oxalic acid, **M**alonic acid, **S**uccinic acid, **G**lutaric acid, **A**dipic acid, **P**imelic acid

Purpose of reagents:

- **Hydration** $(+H_2O)$: $HgSO_4 + dil.H_2SO_4$
- **Dehydration** $(-H_2O)$: $conc \cdot HgSO_4 + Heating$ $at\ 170^0 C (or) P_4O_{10} (or) Al_2O_3 + Heating\ upto\ 350^0 C$
- **Dehydrohalogenation(-HX):** alc.KOH
- **Dehalogenation(-X):** Zn dust
- **Reduction** $(+H_2)$: $Zn-Cu + C_2H_5OH\ (or)\ Zn-Hg + conc.HCl\ (or)\ H_2N-NH_2\ (or)\ H_2/Ni\ (or)\ Pt\ (or)\ Pd$; HI / Red P_4; $LiAlH_4$; $NaBH_4$
- **Partial reduction** $(+H_2)$: $H_2 + Pd/BaSO_4$ in quinoline
- **Oxidation** $(+O\ or\ -H_2)$: $Alk.KMnO_4\ (or)$ acidified $K_2Cr_2O_7\ (or)\ Cr_2O_3/H_2SO_4$
- **Partial reduction** $(-H_2)$: $PCC\ or\ PDC$
- **Hydroboration oxidation:** to convert alkene to alcohol
  $B_2H_6 + H_2O_2 + aq.NaOH$
- **Decarboxylation:** $(-CO_2)$: $NaOH + CaO + Heat$
- **Halogenation** $(+X)$: $X_2/h.v.$ (sunlight) (or) $Cl_2/FeCl_3$ (or) Br_2 in CH_3COOH (or) Br_2 in CS_2 at 0°C
- $\alpha-$ **Halogenation (+X at α carbon):**
  Cl_2 + Red P_4
- **Nitration (substitution of $-NO_2$):**
  $Conc.HNO_3 + Conc.H_2SO_4\ (or)\ KNO_2/DMF$
  Sulphonation (sub. of $-HSO_3$) :
  conc. $H_2S_2O_7$ (oleum)
- **Alkylation (sub. of -R):** $RX\ \&\ Anhyd.\ AlX_3$
- **Acylation(sub.of -COR):** RCOX & $Anhyd.\ AlX_3$
- **Aldol condensation:** dil. NaOH
- **Ketol condensation:** $Ba(OH)_2$
- **Cannizzaro condensation** (For aldehydes does not contain $\alpha-H$): KOH or NaOH
- **Hydrolysis of CN:** $\begin{array}{c|l} C & N \\ O & H_2 \\ OH & H \end{array} \rightarrow -COOH + NH_3$

Hydrolysis of NC: $\begin{array}{c|l} N & C \\ H & OH \\ H & OH \end{array} \rightarrow NH_2 + HCOOH$

- **Alkaline KMnO$_4$ (Baeyer's reagent) :** To detect unsaturation & oxidation
- Red P_4 + $conc\ HI$: $To\ reduce -CHO, -CO, -COOH, -CH_2OH\ to -CH_3$
- $ZnHg + conc.HCl : To\ reduce -CO\ to\ CH_2$
- **Removal of** $-CO$: $Br_2 + KOH$
- **Distinguish 1^0, 2^0, 3^0 Alcohols:** ZnCl$_2$+Conc.HCl
- **Distinguish aldehydes from ketones:**
  - ❖ **Tollen's reagent** (Ammonical $AgNO_3$)
  - ❖ **Fehling's solution**(alk. $CuSO_4$ + sodium potassium tartarate)
  - ❖ **Schiff's reagent:** decolouration of rosaniline hydro chloride with SO_2.
  - ❖ **Benedict's Solution:** alk CuSO$_4$ + sodium potassium citrate
- To neutralise acid: pyridine

Named reactions:

- **Hydroboration-oxidation:**
  $$H_3C-CH=CH_2 \xrightarrow[2)H_2O, H_2O_2, NaOH]{1)B_2H_6} CH_3CH_2CH_2OH$$

TRICK:
(1) Addition of water
(2) Follow Anti Markovnikov rule

- **Esterification:** $CH_3COOH + HOH_5C_2 \xrightarrow{H^+} CH_3COOC_2H_5 + H_2O$
- **Kolbe's:**
  $$C_6H_5OH \xrightarrow[2)CO_2, H^+]{1)NaOH} C_6H_5(OH)\ COOH$$
- **Reimer - Tiemann:**
  $$C_6H_5OH \xrightarrow[2)aq.NaOH]{1)\ CHCl_3} C_6H_5(OH)\ CHO$$
  [Intermediate: Benzalchloride; Intermediate species: dichlorocarbene(:CCl$_2$)]
- **Williamson's:**
  $$C_2H_5Cl + C_2H_5ONa \rightarrow C_2H_5OC_2H_5 + NaCl$$
- **Rosenmund's:**
  $$C_6H_5COCl + H-H \xrightarrow[BaSO_4]{Pd} C_6H_5CHO + HCl$$
- **Stephen:** $CH_3CN \xrightarrow[2)\ H_3O^+]{1)\ SnCl_2, HCl} CH_3CHO + NH_3$
- **Etard:**
  $$C_6H_5CH_3 \xrightarrow[2)\ H_3O^+]{1)\ CrO_2Cl_2, CS_2} C_6H_5CHO$$

- **Gattermann-Koch:**

$$C_6H_6 \xrightarrow[2)\ Anhyd \cdot AlCl_3/CuCl]{1)\ CO,\ HCl} C_6H_5 \cdot CHO$$

- **Clemmensen:**

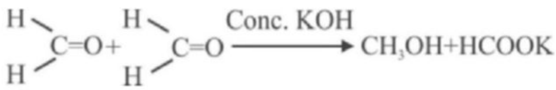
$$CH_3COCH_3 \xrightarrow[HCl]{ZnHg} CH_3CH_2CH_3 + H_2O$$

- **Wolff-Kishner:**

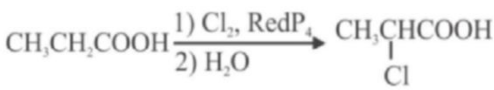
$$CH_3COCH_3 \xrightarrow[-H_2O]{NH_2NH_2} (CH_3)_2C = NNH_2$$

$$\xrightarrow[Heat]{KOH,\ ethylene\ glycol} CH_3CH_2CH_3 + N_2$$

- **Cannizzaro:**



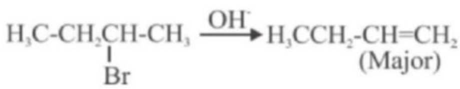
- **H.V.Z.:**



- **Finkelstein:**

$$CH_3Cl + NaI \xrightarrow{dry\ ether} CH_3I + NaBr$$

- **Swarts:** $CH_3Br + AgF \rightarrow CH_3F + AgBr$
- **Saytzeff:**



- **Wurtz:**

$$CH_3Br + 2Na + BrCH_3 \xrightarrow{dry\ ether}$$

$$CH_3 - CH_3 + 2NaBr$$

- **Fitting:**

$$C_6H_5Br + 2Na + BrC_6H_5 \xrightarrow{dry\ ether}$$

$$C_6H_5C_6H_5 + 2NaBr$$

- **Wurtz Fitting:**

$$C_6H_5Br + 2Na + BrCH_3 \xrightarrow{dry\ ether}$$

$$C_6H_5CH_3 + 2NaBr$$

- **Gabriel pthalimide:**

$$C_6H_4(CO)_2NH \xrightarrow[\substack{ii)\ RX,\Delta \\ iii)\ aq.NaOH}]{i)\ alc.KOH}$$

$$C_6H_4(COONa)_2 + RNH_2(aliphatic)$$

- **Hoffmann bromamide degradation:**

$$RCONH_2 + Br_2 + 4NaOH \rightarrow RNH_2$$

$$+2NaBr + Na_2CO_3 + 2H_2O$$

- **Diazotisation:**

$$CH_3NH_2 + HNO_2 \xrightarrow[HCl]{NaNO_2} CH_3N_2Cl$$

$$\xrightarrow{H_2O} CH_3OH + N_2 + HCl$$

- **Sandmeyer:**

$$C_6H_5N_2Cl + HBr \xrightarrow{Cu_2Br_2} C_6H_5Br$$

$$+N_2 + HCl$$

- **Gatterman:**

$$C_6H_5N_2Cl + HCl \xrightarrow{Cu} C_6H_5Cl$$

$$+N_2 + CuCl$$

- **Carbyl amine:**

$$C_6H_5NH_2 + CHCl_3 + 3KOH$$

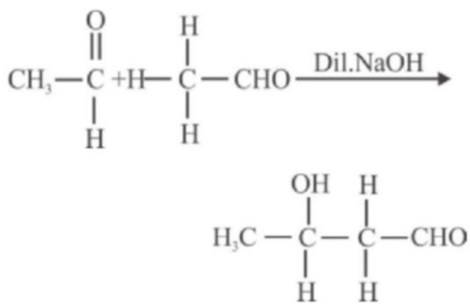
$$\xrightarrow{\Delta} C_6H_5NC + 3KCl + 3H_2O$$

- **Idoform:**

$$CH_3CHO + 4KOH + 3I_2 \rightarrow CHI_3$$

$$+HCOOK + 3KI + 3H_2O$$

- **Aldol Condensation:**



- **Cross Aldol Condensation:**

$$CH_3CHO + C_2H_5CHO \xrightarrow[2)\Delta]{1)\ NaOH}$$

$But - \mathbf{2} - enal +$

$Pent - \mathbf{2} - enal +$

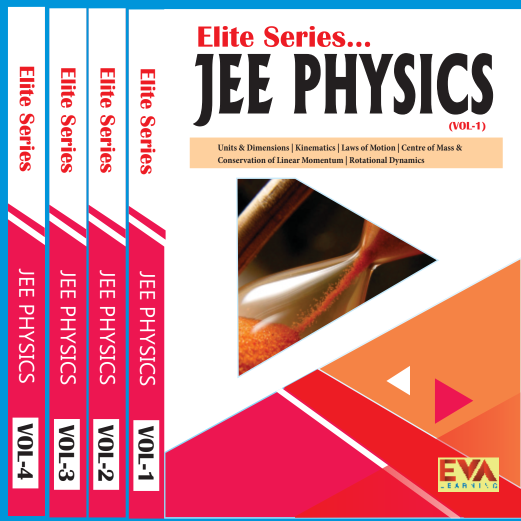
$\mathbf{2} - Methyl\ But - \mathbf{2} - enal +$

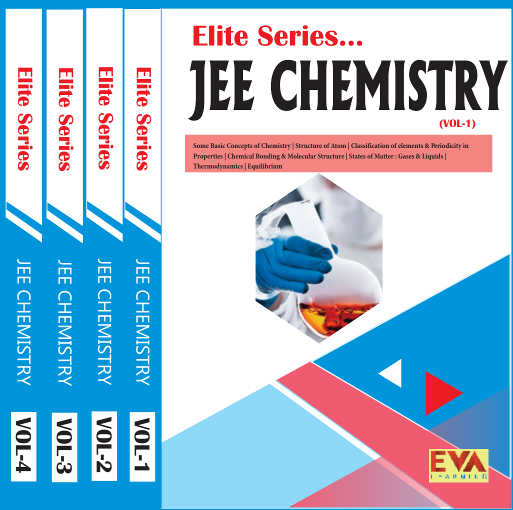
$\mathbf{2} - Methyl\ pent - \mathbf{2} - enal$

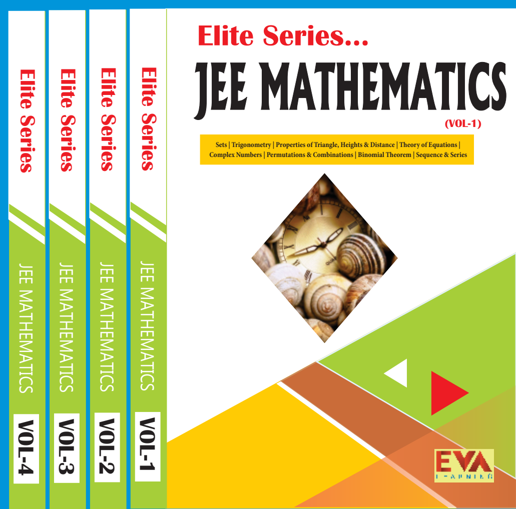
Bridge with Champions to Shape your Success

Class XI & XII

JEE PHYSICS
JEE CHEMISTRY
JEE MATHEMATICS







Highlights

- Chapter wise theory
- Chapter wise MCQ's with detailed solutions
- Hand picked treasures in MCQ's
- Graph based questions
- Matching type questions
- Assertion & Reason based questions
- Chapter wise JEE (online & offline) questions

Advantages

- ✔ The best price guaranteed
- ✔ Cover Page with your branding
- ✔ On-time dispatch

Exciting Offer

Avail a Complementary Test Series

For more information & details Contact No: 9036023567, 8095851469, 9739711829 | email-id: info@pcmbtimes.com